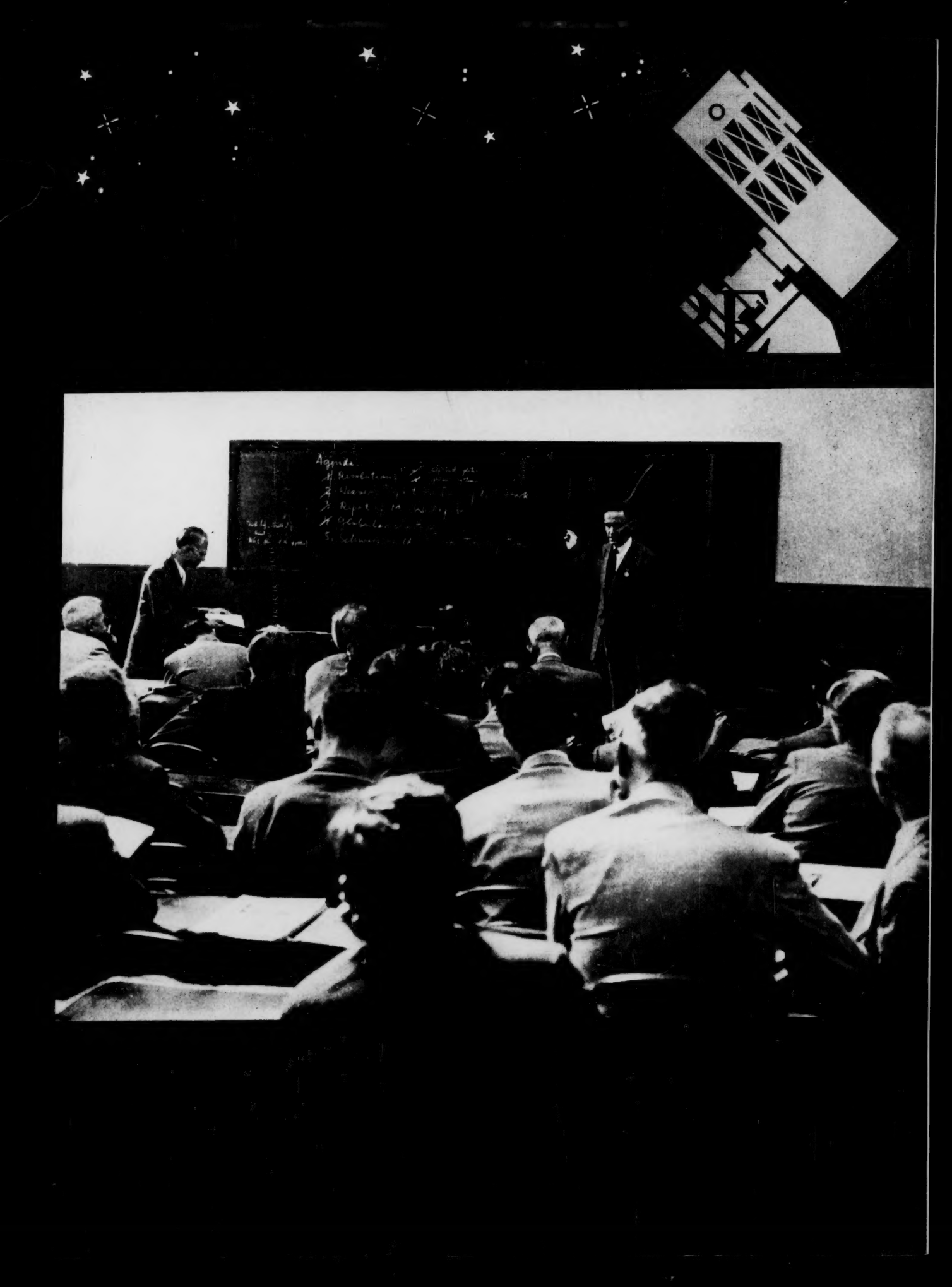
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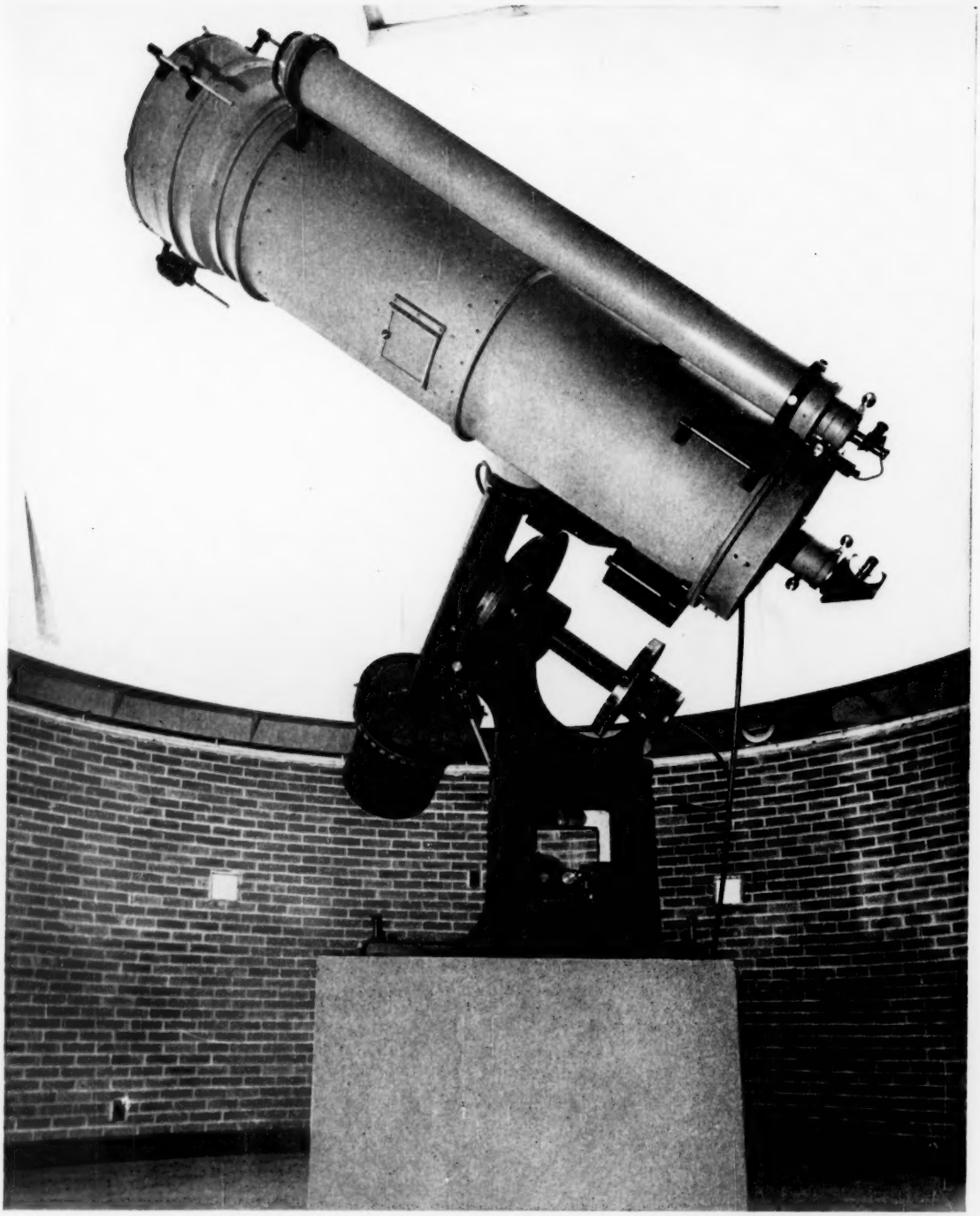

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Vol. XV, No. 2 DECEMBER, 1955

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The Well-informed Amateur

ARE YOU able to answer questions on astronomy? This query is raised by G. R. Wright, observing chairman of the Astronomical League, in an appeal to every amateur astronomer to keep himself informed about his hobby and to be able to answer friends' questions.

In the September-October, 1955, number of the Astronomical League *Bulletin*, Mr. Wright says,

". . . It is my belief that you owe to your society and the fascinating hobby a debt which only you can pay. I do not have reference to the monetary cost of belonging to one of these groups. I am sure that you have friends who know that you belong to such a society and as a member of that society they should be able to turn to you and ask questions on astronomy and get an answer."

Then the National Capital Astronomers' member goes on to point out that only a small percentage of amateurs are very well qualified to represent themselves as amateur astronomers, and that a great many others know relatively little about astronomy and are taking no steps to do anything about it. He continues,

"Do you feel that it is asking too much of our members to be able to explain some of the simple things about astronomy? Say, for instance, that they know 15 to 20 constellations, the names of the very brightest stars, something of the mythology of the constellations and to keep track of the naked eye planets? Understand, I am not asking for a learned discussion on these subjects, but just that you know something about them, can point them out, and can tell a little about them."

The remainder of Mr. Wright's discussion concerns the theme, "Astronomy is fun if you do it yourself." He does not expect each amateur to take up a serious, professionally recognized observing program. But he does want each person to put some energy into learning more, by the "do-it-yourself" method.

"I know that most every one feels that before he can do anything in the way of observing he must have a telescope, and even those who have telescopes feel that if they only had a larger telescope then they would try to do something worthwhile in astronomy. You can do a lot in astronomy and have a lot of fun with just what you have, even if you don't have a telescope and have to make 'naked eye' observations. Stop and think how much astronomy was learned before there were telescopes. . . . Don't wait for a large telescope, don't wait until next year, do it now and 'do it yourself' and you will have pleasure. . . . Stop and comprehend the meaning of what you observe, and by so doing you will learn more about astronomy and will be able to convey this information to others."

Astronomers from all over the world mingled with the crowds of O'Connell Street in Dublin, following the ceremonial opening of the International Astronomical Union assembly, on the morning of August 27, 1955. The author of this article is seen at the extreme left. Photograph by the Irish "Times."

REPORT FROM DUBLIN

FRANK K. EDMONDSON, *Goethe Link Observatory, Indiana University*

THE NINTH general assembly of the International Astronomical Union, held in Dublin this year, can be summarized in the following terms:

First, there was the largest attendance in the history of the union. More than 800 delegates and guests representing 41 countries were present. The general assembly voted to accept an invitation to hold the 10th general assembly in Moscow in 1958.

Second, a fundamental change in the membership structure of the union was approved unanimously. New officers were elected after the by-laws had been amended to add one more vice-president to the executive committee. Dr. André Danjon, Paris Observatory, is the new president; Dr. Boris Kukarkin, Sternberg Institute, Moscow, was elected vice-president to replace Dr. V. A. Ambarzumian, Armenian Academy of Sciences; and Dr. Otto Heckmann, Hamburg Observatory, was elected to the newly created vice-presidency.

Third, there were two top-level symposia and four joint discussions of the work of two or more commissions.

Fourth, the meetings of the majority of commissions produced many instances of constructive achievement and co-operation, the need for which brought the union into existence originally. The commission meetings still remain the most important single part of an IAU assembly.

Fifth, there was the warm hospitality of the Irish people and their government, and the effective arrangements made by Prof. H. A. Brück, director of Dunsink Observatory, and his associates.

These pictures show the front and reverse sides of the IAU badge, nearly full size. The design reproduces an ancient symbol of the sun.

Registration began on Saturday, August 27th, and most of the delegates were checked in by the time the office closed on Sunday evening. Each delegate and registered guest received an attractive portfolio with an early picture of Dunsink Observatory on the outside, and containing a detailed program of the meeting, a list of delegates and guests, a pass for free bus transportation in Dublin for the week, and other useful materials. The congress badge was a replica of a 3,000-year-old Irish sun symbol. The original, about three inches in diameter and made of 24-carat gold from the Shannon River, is in the National Museum in Dublin.

The ceremonial opening took place on Monday morning at the Ambassador Cinema, conveniently located across O'Connell Street from the Gresham Hotel where a number of delegates were staying. A selection of Irish instrumental music and traditional songs made up part of the program. The entire diplomatic corps and many members of the government were present on this occasion.

The prime minister of the Irish Republic, John A. Costello, opened the

assembly with two brief paragraphs in the Irish language. Then, continuing in English, he pointed out that ours was the greatest scientific congress ever held in Ireland, and said:

"The Irish language was the first vernacular in Western Europe to be used in the service of astronomy. For over a thousand years—in fact, since the fifth century—our annals have been chronicling solar and lunar eclipses.

"Among the symposia listed for the present conference there is one on the comparison of the large-scale structure of our galaxy with that of other stellar systems, and you will pardon me if in this regard I recall the name of an Irishman. It was William Parsons who, by means of what was in his time the largest telescope in the world, discovered a century ago the spiral nature of the nebulae or 'island universes' which fill space and which it is your privilege to study. . . .

"We like to think that we are a generous and warmhearted people. On behalf of that people I wish that God may speed and prosper your work and I bid you *céad mile fáilte*, an Irish phrase which, translated into small astronomical figures, means, 'Welcome multiplied by 10 to the power of five.'"

The group photograph (reproduced on page 78) was taken immediately after lunch and just preceding the first of two sessions of the general assembly. The opening day was completed with a reception by the prime minister and the Irish government in Dublin Castle. We received an inkling of what was in store for us when we found that the dining facilities at Newman House were not going to be open that evening because of the reception. After going up the great stairway to St. Patrick's Hall and being greeted by the prime minister and others in the receiving line, we found a lavish buffet spread on tables in several rooms of the castle. The spacious halls of this beautiful building were filled with astronomers talking shop long after the official end of the reception. Several of us had an opportunity to talk with Eamon de Valera, first prime minister of the Irish Republic, an experience in a way comparable to speaking with George Washington.

On the platform at the ceremonial opening were Dr. H. A. Bruck, director of Dunsink Observatory (speaking), Mgr. P. de Brun, head of the Dublin Institute for Advanced Studies, Eamon de Valera, and Ireland's prime minister, John A. Costello (extreme right). Irish "Times" photograph.

Another enjoyable social event took place late on the afternoon of Wednesday, August 31st. This was a reception by the president of Ireland at his official residence in Phoenix Park, a stately white mansion surrounded by fine green lawns and beautiful gardens. In addition to the astronomers, the guests included many of Ireland's political and social leaders. As we lined up to be introduced individually to President and Mrs. Sean T. O'Kelly, clearing skies made many of us regret not bringing our cameras, for this was probably the most photogenic part of the entire meeting. Entertainment was provided alternately by a military band and a group of marching Irish bagpipers and drummers. Buffet style refreshments were served under tents, and tables and chairs were set out on the spacious lawns.

Sunday, September 4th, was devoted to all-day tours to Killarney and Connemara, by invitation of the government and the Irish tourist board. Although

The scene at the residence of the president of Ireland on August 31st. Photograph by Barbara Federer.

equal numbers went on each tour, most Americans chose Killarney, which was why my wife and I chose Connemara. Lunch was served on the train before our arrival in Galway. In spite of the dark and cloudy weather, we were able to see some of the magnificent scenery of the Connemara district during a five-hour bus tour. A stop of more than an hour in the small town of Cong gave us a chance to walk around to see Ashford Castle and the ruins of an old abbey.

On the way home, high tea was served on the train, which meant that many of the astronomers were full professors in the best sense of the word. This and the Killarney trip were made on what are known as radio trains—there is a public address system and a disk jockey aboard to entertain the passengers. The son of a well-known astronomer was interviewed by the announcer: "Do you want to be an astronomer when you grow up?" The reply was, "No, I want to be a scientist."

Visits to Dunsink Observatory, seven miles from the city, were arranged for 200 persons on each of four evenings during the week. We could inspect the well-kept equipment and learn at first hand about the work of the observatory. An image of the moon on a television screen, using equipment brought from Cambridge, England, for demonstration on the occasion, was the first example of this method of observing that many of the visitors had seen in operation. Tea was served in the director's residence, and all of us appreciated the hospitality of the Brücks and admired their courage in having a total of 800 guests in their home.

A number of receptions were held during the week, by the various embassies for delegates from their respective countries, and guests. The reception for Americans was given at the American Embassy by Ambassador and Mrs. W. H. Taft, III, on September 3rd.

One of the hosts to the astronomers at Dublin was Prof. T. Nevin, of the physics department, University College, who is shown here with Mrs. Nevin. Irish "Times" photograph.

Mrs. Margaret W. Mayall, recorder of the American Association of Variable Star Observers, exchanges greetings with the president of Ireland. Photograph by Barbara Federer.

The serious work of the individual commissions began on the morning of August 30th and continued through the week. It is customary for an astronomer to attend the meetings of commissions on which he holds membership, and to sit in on other commission meetings if he feels so inclined. In this way, one gets some very interesting impressions of astronomers as well as subject matter. In a few cases, there were long discussions over what appeared to an outsider to be trivialities. In others, the commission meeting would consist of the reading of the printed draft report with very little discussion. In most cases, however, the commissions had additional work to do, and this was outlined in an agenda. My impression is that some of the commissions could profitably use much more time than was allocated to them on the program, and that others would probably not need to have a formal meeting at all. Perhaps there is no practicable way to make decisions like this in advance.

The two commissions on which I hold membership — 20, Positions and Movements of Minor Planets, Comets, and Satellites, and 30, Stellar Radial Velocities—were both of the prepared agenda variety. The field of the first is one in which co-operation is very important to avoid wasteful duplication of effort. There is more than enough work for those active in the field, and it is highly important to have their efforts properly distributed. For example, Dr. Paul Herget, University of Cincinnati Observatory, has access to high-speed computing equipment, and he offered to perform perturbation calculations for all astronomers who will send him the necessary information.

A highlight of this session was the trading of 105 asteroid ephemerides from the Rechen-Institut in return for a list of apparent places of fundamental stars previously computed by the Leningrad Institute. This will doubtless serve to increase the efficiency of both institutions. The commission was pleased to learn that the 1956 minor planet ephemeris, published in Leningrad, would give us the asteroid names in Latin characters, instead of in Russian. Financial support was voted for the British Astronomical Association comet catalogue now in preparation, and for continued publication of the *Minor Planet Circulars* by the Cincinnati Observatory.

Radial-velocity work also requires co-operation in order to produce the most effective results. A large part of the meeting of Commission 30 was devoted to a discussion of standard stars for radial-velocity measurements. This subject has become increasingly important with the current development of major radial-velocity programs in the Southern Hemisphere. Interesting progress reports on objective-prism radial velocities were given by C. Fehrenbach, Pic du Midi Observatory, and by O. A. Melnikov, of Poulkovo Observatory. A. Blaauw, Yerkes Observatory, discussed the recommendations of the Groningen conference in 1953 as they applied to radial-velocity work. He stressed the need for radial velocities of faint stars, particularly of early-type supergiants, in order to check the 21-cm. radio velocities at large distances. Bart J. Bok, Harvard Observatory, requested co-operation from as many observers as possible on a program of faint *A* and *G* stars at the south galactic pole.

Commission 40 (Radio Astronomy) held two very important business sessions. The IAU-sponsored Jodrell Bank symposium, held just before the Dublin meeting, had already provided opportunity for discussion of recent research (see Dr. Bok's report in the November issue). At Dublin, the topics included: a catalogue of radio sources, terminology, galactic co-ordinate tables and other tables, frequency allocations, standard sources for calibration, publication questions, international planning of programs, a list of radio observatories and their main projects, and suggestions for future symposia.

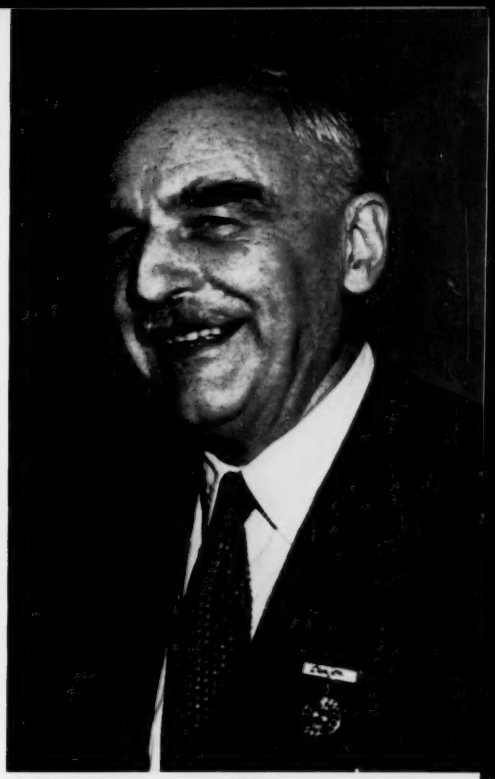
To an outsider, the most interesting and important subject was the question of radio frequency allocations. Many radio astronomers are finding it increas-

ingly difficult to carry on their work because of interference from television and high-frequency radio stations. This type of interference is already a very serious matter in some of the more highly developed countries. A solution to the problem involves more than merely having certain frequency bands reserved for scientific purposes. Unwanted harmonics from stations broadcasting on other frequencies can cause trouble for the radio astronomers. They are measuring such exceedingly small quantities that any interference is troublesome. It is important that government authorities in all countries where there is television and high-frequency broadcasting be made to realize the serious nature of this problem and the importance of requiring stations to provide their equipment with all necessary safeguards to avoid broadcasting harmonics. Government cooperation has already been secured in a few countries, and it is fervently hoped that others will join in.

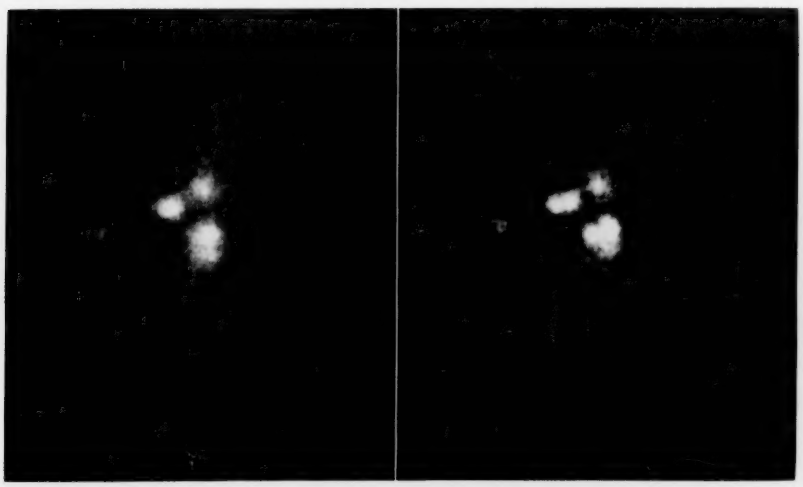
Commission 17 (Motion and Figure of the Moon) spent most of its time discussing the limb corrections now being prepared by C. B. Watts, at the Naval Observatory in Washington. A comparison was made of the probable error of occultation observations reduced both without and with application of the limb corrections. The dramatic result is that one occultation with corrections applied is worth, on the average, as much as five or six occultations without them.

Commission 28 (Extragalactic Nebulae) found it necessary to schedule two sessions in addition to the one originally planned. An evening meeting provided an opportunity for the cosmologists to have their say, and the other extra session was a discussion of problems of the Magellanic Clouds. At the first session, W. Baade, Mount Wilson and Palomar Observatories, gave an excellent summary of the present state of extragalactic research. Most of his remarks were devoted to projects now under way, or which should begin in the near future to provide data for helping to solve the distance problem. Work in this field is obviously restricted to the largest telescopes; consequently there is less opportunity for the kind of co-operation found in some of the other commissions. The new value of the red-shift constant given by Baade is 180 to 200 kilometers per second per megaparsec, which is considerably smaller than the original Hubble value of 550. This points out the tremendous importance of the work now being carried on for the measurement of extragalactic distances, which is needed to give us a definitive value of this constant.

The two symposia in their printed form will be very important contributions to astronomical literature. However, in their oral presentation, the sessions were so long as to be almost beyond the limits of physical endurance for many of the listeners. The symposium on nonstable stars was, at least, divided into afternoon and evening sections. One of the most exciting and controversial papers was "On the Nature and Origin of the T Tauri Stars," by G. H. Herbig, of Lick Observatory. He attempted to give a positive answer to the question, "Are the T Tauri variables new stars, recently formed or still forming within the nebulae, or are they ordinary field stars that have encountered the gas and dust clouds accidentally, and are in process of being modified—perhaps rather superficially—by their environment?" He presented evidence that the T Tauri stars as a class are newly formed. Two objects of stellar appearance are visible on Lick plates taken in December, 1954, and were not present on plates taken in January, 1947. Dr. Herbig stresses the fact that the apparently new objects did not develop out of any stars that had been visible at those positions in the past.



The new president of the IAU is Dr. Andre Danjon, director of the Paris Observatory. This is an Irish "Times" photograph.



These pictures may be evidence of the birth of stars. They were taken with Lick Observatory's 36-inch reflector in 1947 and 1954, nearly eight years apart, of a region 1.5 degrees from the center of the Orion nebula. North is at the top. The two brightest stars in the first picture are eight seconds of arc apart. In the 1954 photograph, each of these stars appears to have a 17th-magnitude companion, where no star of even one tenth their brightness was detectable before. Dr. Herbig suggests that they may be T Tauri variable stars in the earliest stage of their history, or possibly that this knot of seven starlike objects, embedded in a minute nebula, may eventually develop into a highly luminous multiple star like the Trapezium in the Orion nebula. Lick Observatory photographs.

The symposium on comparison of the large-scale structure of the galactic system with that of other stellar systems would have been easier to listen to if it had also been divided into two sessions. All 13 speakers had something worthwhile to say. Special mention should be made of W. W. Morgan's powerful new optical techniques, and the important work on the Magellanic Clouds reported by M. W. Feast, A. D. Thackeray, and A. J. Wesselink. H. C. van de Hulst's discussion of the distribution of hydrogen in the galactic system presented the latest Dutch results on the spiral structure in our galaxy. So much has been accomplished that it is hard to realize that the very beginnings of the subject were reported as recently as 1952 at the Rome meeting of the IAU.

The joint discussions were smaller in

At one of the larger sessions, the author and his wife occupied front-row seats. At Dr. Edmondson's right is the retiring Astronomer Royal of England, Sir Harold Spencer Jones. Irish "Times" photograph.

scope than the large symposia. In fact, they came closer to my concept of what an ideal IAU symposium should be. The session on photoelectric image tubes and their astronomical applications gave us an exciting view into the probable future of observational astronomy.

The session on fundamental star catalogues brought out widely diversified views on the proper choice of observing programs for fundamental stars. Most of the major observatories doing this kind of work were represented at the session. Of particular interest was G. van Herk's report on absolute determinations of declinations from azimuth observations at the Leiden Observatory's equatorial station during the years 1931-33 and 1947-51.

The discussion that followed the formal papers was divided by the chairman, Dr. Heckmann, into three categories, traditional methods, untraditional methods, and reactivation of southern observatories. It was most encouraging to hear that a new observatory in Santa Cruz, Argentina (pictured on the facing page), is to begin meridian work. This, of course, cannot completely make up for the half dozen or more Southern Hemisphere observatories that seem to have given up work in this field. All of us who are concerned with problems of galactic structure and stellar motions should take a keen interest in the continuation of this important observing in the Southern Hemisphere. At the present time the Cape Observatory in South Africa carries the burden practically alone.

The most important single action of the general assembly was the change in the membership structure of the union. In the past, all full-fledged members of the union had to be members of commissions. Some commissions have become awkwardly large, and others apparently were created to provide membership for astronomers who could not be classified in terms of the previously existing commissions. However, astronomers who were not members of commissions could be appointed as temporary class B delegates to attend a general assembly.

In the future, there will be no division into two classes, and members of the union will not necessarily belong to commissions. How well this will work out remains to be seen. The problem has been considered very carefully by a special committee consisting of J. H. Oort, H. Spencer Jones, P. G. Kulikovsky, and B. Stroemgren, and it was adopted by a unanimous vote after virtually no discussion from the floor. Despite this, I heard reservations and doubts expressed later by a number of people, and we shall have to wait for the future to tell us whether this was a wise move or not.

The unanimity of the voting at Dublin was in sharp contrast to the Rome meeting, showing that most of the earlier tensions have been alleviated. Most votes were by acclamation; the one taken by roll call of nations had to be done that way for legal reasons. The Russian invitation to Moscow for 1958 was seconded by the American delegation, and our tentative invitation to hold a meeting in California in 1961 was seconded by the Russians.

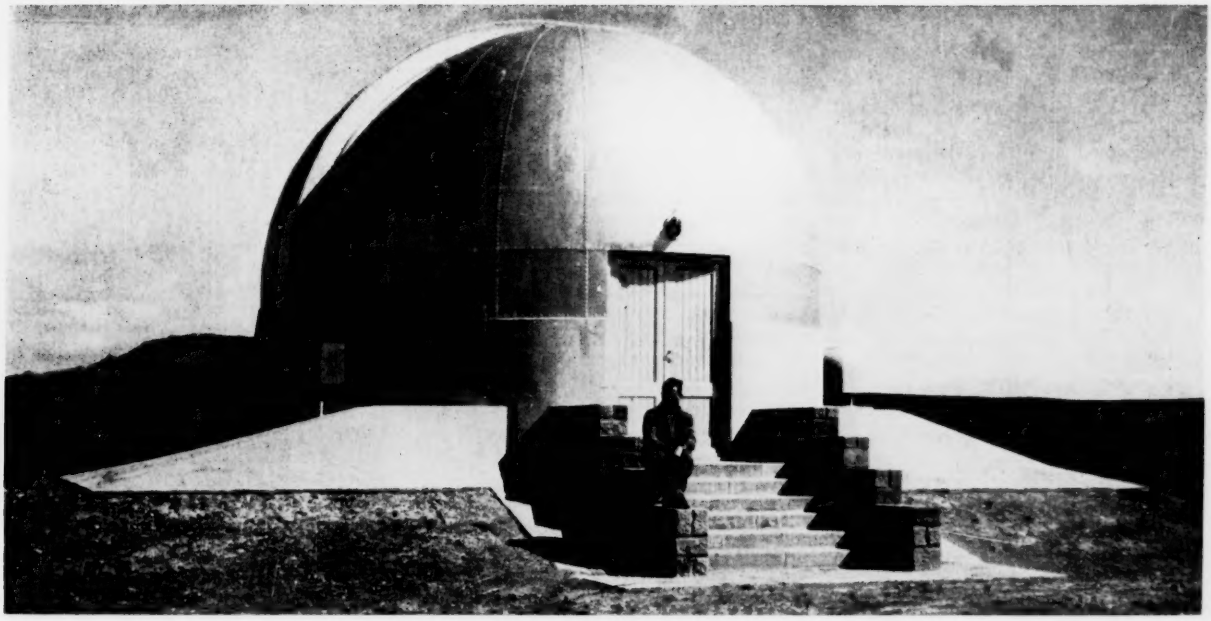
The meeting ended with a dinner in Mansion House, on Monday, September 5th. This was held in the same large hall that had been used for the opening session of the general assembly, and for the symposia and some of the joint discussions. There were after-dinner speeches by representatives of the different institutions that had served as our hosts and by delegation leaders of several member countries of the union.

On Tuesday about 500 astronomers traveled to Belfast by special train as guests of the government of Northern Ireland. Immediately upon our arrival, we were taken to the city hall for a reception and late morning coffee as guests of the city, and an hour later were served luncheon in Whitlow Hall at the university as guests of the state. Both the governor and the prime minister of Northern Ireland were present and spoke briefly following the luncheon. We then had a bus tour of the city of Belfast and were driven past the impressive parliament buildings at Stormont.

After this tour, we were taken by train to Armagh, to visit the observatory there, and to partake of high tea in a nearby schoolhouse. Dr. Eric Lindsay and his staff held open house at the observatory. Prof. E. J. Opik's meteor camera and a fine display of plates taken with the Armagh-Dunsink-Harvard telescope in South Africa attracted much attention.

Many astronomers started their homeward journeys directly from Belfast, or proceeded to the meeting of the Royal Astronomical Society in Glasgow. Others returned to Dublin to spend a few more days in Ireland before finally leaving the scene of this busy and fruitful congress.

Dr. H. L. Alden, of the University of Virginia's McCormick Observatory, here conducts a meeting of Commission 24, on stellar parallaxes and proper motions. Seated at the table is Dr. K. A. Strand, of Dearborn Observatory.



The dome of the 7½-inch meridian circle of the new Felix Aguilar Observatory in southern Argentina. Elliptical in shape, this nonrotating dome has shutters which open to provide a wide slit in a north-south direction.

OBSERVATORY IN PATAGONIA

COMDR. GUILLERMO O. WALLBRECHER, *Director, La Plata Observatory*

THE astronomical observatory of the La Plata National University is constructing a branch station in Patagonia, designed especially for meridian astronomy. Its chief instrument will be a Repsold meridian circle of 7½-inch aperture equipped with a motor-driven micrometer, and auxiliary apparatus for precision time service will be installed.

The station is situated on the bank of the Leona River, in Santa Cruz, about 925 feet above sea level, at longitude 72° 3′ west, latitude 49° 50′.7 south. It is named after Felix Aguilar, an eminent Argentinian geodesist and astronomer, who died in 1943, having been director of La Plata Observatory (later Eva Peron Observatory) since 1934. He had laid plans for the southern station as early as 1935.

The work of construction began in 1947, the first stage ending in 1952. Nevertheless, it has not been possible to start operations immediately because of lack of a workshop, of vacuum pumping equipment, and of the underground chamber for the clocks, but we trust these will become available shortly.

It is hoped that in 1956 we can begin operation of this station. The complete installation will also have a geophysical section, for which we have plans to install meteorological instruments, seismographs, ionospheric apparatus, and the like.

The mean temperature is about 46° Fahrenheit, with minima of nearly zero between May and September. In the summer, from December to February, the mean is about 52° and the maximum reaches 80°. The mean barometric pressure of 28.7 inches varies little during the year, while the humidity in summer is some 40 per cent, and 65 per cent in the winter.

Rain is scarce—about three inches per year—but cloudiness is prevalent, with only eight hours of sunshine per day in the summer and about 3½ hours in the winter. Only 60 nights a year are absolutely clear during the evening hours from 8 o'clock to midnight. Winds are strongest in spring and summer, with an average speed of 5 on the Beaufort scale of wind velocities.

Despite its unfavorable climate, the Felix Aguilar station will play an important role in meridian astronomy programs, as it is the southernmost observatory of its kind. And the complete project results in the creation of a scientific community in the far-off region of southern Patagonia, where all the comforts of civilization are provided for the staff and visitors.

This is the astronomer's residence, with the meridian circle dome to the left.

ASTRONOMICAL SCRAPBOOK

Lohrmann's Atlas of the Moon

IF YOU HAD BEEN an amateur astronomer 150 years ago, and wished to take up the study of the moon's surface, you would have been seriously handicapped by the lack of adequate maps. The best at that time was by the Goettingen astronomer, Tobias Mayer, published in 1775, and on so small a scale that the lunar diameter was only 7½ inches. It was the only moon map of the time that did not depend on mere eye estimates for crater positions.

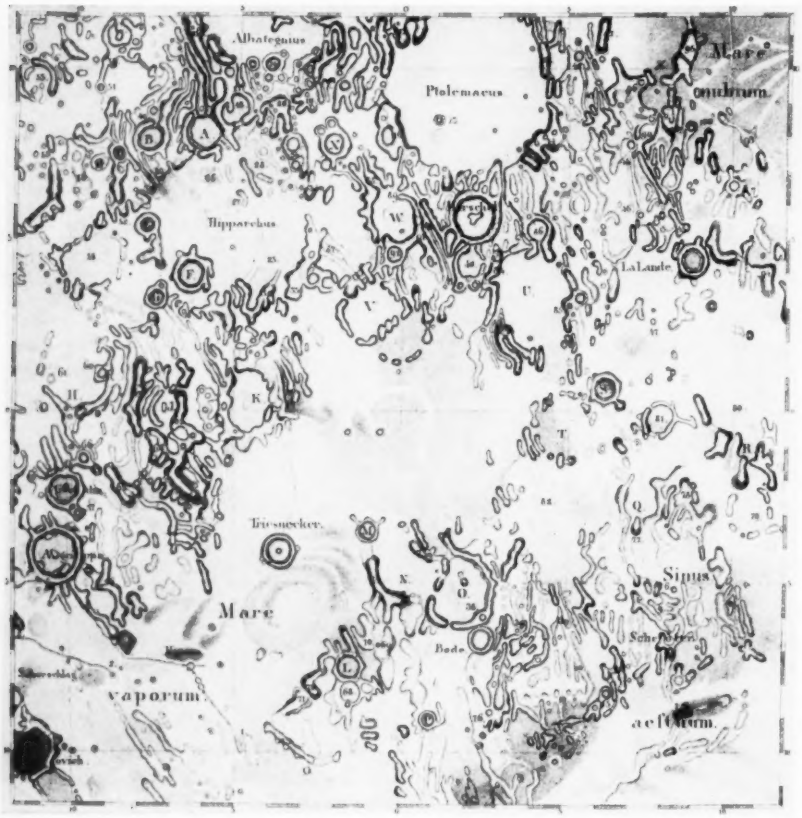
Supplying this lack was the self-appointed task of a 25-year-old German amateur astronomer, Wilhelm Gotthelf Lohrmann (1796-1840). A native of Dresden, he was occupied in the geodetic survey of the kingdom of Saxony. This gave him a familiarity with practical cartography of the greatest value in his lunar project.

His aim was "to represent the moon's surface features, and their gradations of light and shade, with all possible accuracy, and to carry out both measurements and drawings by scientifically sound methods." Both K. F. Gauss and J. F. Encke, the leading German astronomers of the day, encouraged the undertaking, and the latter furnished the mathematical formulas for the determination of crater co-ordinates.

After some experimental observations, in 1822 Lohrmann erected for the purpose an observatory on the top floor of his house in the Dresden suburb of Pirna. There was no dome, but instead a roof of planks which could be removed individually. Lohrmann's principal telescope was a refractor of 6-foot focal length, with a 4.8-inch achromatic objective by Fraunhofer; it was fitted with a filar micrometer. The instrument was equatorially mounted on a stone pier, and had slow motions but no driving clock. There was also a 3.3-inch Fraunhofer refractor, and a small transit instrument for time determinations.

So equipped, Lohrmann enthusiastically began detailed charting of the moon, on a scale of 38.4 inches to its diameter. To supply accurate reference points, he established from micrometric measurements the selenographic latitudes and longitudes of 79 craters. The pencil sketches made at the telescope were afterwards carefully combined into 25 ink drawings, which together covered the entire visible face of the moon.

W. G. Lohrmann, the first man to map the moon's surface by modern methods, after a portrait by Roessler.



The central portion of the moon, depicted in Lohrmann's book of 1824, is here reproduced at slightly over half the original scale. North is below and east to the right, as is conventional in lunar maps. The area shown covers 24 degrees in selenographic latitude and 24 degrees in longitude. The lunar "city" discovered by Gruithuisen and mentioned in the text appears here as a group of hills and ridges, 1¼ inches above and ⅞ inch left of the lower right corner.

To describe the relative brightnesses of lunar formations, Lohrmann followed Schroeter in adopting a scale of 0 to 10, where 0 represented black shadows, 5 light gray, and 10 was used for the brightest regions, like Aristarchus. These grades of brightness were carefully represented on the section maps. In drawing crater walls, Lohrmann indicated relief by making the shading darker, the steeper the slope.

The first four of the 25 section maps were published in 1824 in Lohrmann's book, *Topography of the Visible Surface of the Moon, First Installment*. Its 130 pages contain a historical account of lunar studies, a full explanation of the author's working methods, and detailed descriptions of the regions charted.

This was the first modern treatise on selenography. Perhaps because of the book's rarity today, few modern astronomers have mentioned how closely its plan was followed, even in minor details, by the better-known *The Moon* of W. Beer and J. H. Maedler (1837). The merit of the latter book lies much more in its completeness than in its originality.

Even Beer and Maedler's skepticism about life and change on the moon is foreshadowed. Lohrmann's attitude is shown by his footnote added to his description of Sinus Aestuum: "In this region, at longitude 8° E, latitude 6° N, Mr. Gruithuisen believes he has seen a city, a fortress, and other artificial works. He hopes soon to recognize the lunar inhabitants themselves, if they parade en masse through their forest glades, and he

tells much in his selenographical writings of hot springs, minerals, animals, and plants. But these famed discoveries and the elaborate hypotheses based on them have no place in a straightforward book on lunar topography."

When publishing the first installment of his atlas in 1824, Lohrmann stated that he expected to finish the whole project in six years, and then republish all 25 sections together as a general map. However, it was only after many interruptions, partly due to his failing eyesight, that the charts were completed in 1836, but the copper plates for printing them had not been made when Lohrmann died at Dresden on February 20, 1840. He had, however, published a small general map, 15 inches in diameter, in 1838, which was noteworthy for its rich detail.

Publication of the remaining sections of Lohrmann's atlas was undertaken in 1851 by the distinguished selenographer, J. F. J. Schmidt. However, his prodigious energy as an observer did not extend to his business affairs, and it was not until 1878 that the other 21 section maps appeared. The names of two lunar craters record this protracted effort: Barth, after the Leipzig publisher of 1878, and Opelt, after father and son who completed the reductions of Lohrmann's measures of crater co-ordinates.

Lohrmann's work, at the time it was done, far surpassed anything previously attempted, in scope, accuracy, and detail —his atlas contains 7,178 craters and 99 clefts. The long delay in publication kept most of it from the world until after the more extensive lunar maps of Maedler and Schmidt had appeared. Nevertheless, they followed in the paths he had opened, and thus Lohrmann ought to be recognized as the first modern selenographer.

J. A.

Cosmic Ray Conference in Mexico

MOST PHYSICISTS taking the eight-hour bus ride from Mexico City to Guanajuato wondered why they should ever travel to this hidden part of the world. The conference, held September 5-13, was the continuation of an earlier series of international meetings on cosmic rays; the previous one had been held in Bagnères, France, two years ago. It was sponsored by the International Union of Physics and the Mexican federal and the Guanajuato state governments; its chief organizers were Professors M. S. Vallarta, of Mexico, and P. M. S. Blackett, of London.

Guanajuato proved to be a fascinating place—an old silver-mining city with a grand past and a progressive present, typified by the greatly enlarged university building completed only this year.

Formal sessions were held every day except Sunday. The meeting place proved to be singularly effective for the private discussions, from breakfast till late at night, that are so important. The hospitality of officials and townsfolk seemed infinite. Each of the 60 participants can look back to a fruitful conference.

Just what these fruits are is difficult to summarize. I am afraid that they were mostly in the form of a clearer vision of the problems to be solved and not of their actual solutions.

The new feature of this meeting was that eight astronomers (S. Chandrasekhar, J. H. Oort, A. Unsold, T. Gold, K. O. Kiepenheuer, R. Hanbury Brown, A. Schlueter, and the writer) had joined the cosmic ray physicists. While in earlier conferences attention had centered on the multifarious effects set off by the cosmic ray particles upon entering our atmosphere, the time had now become ripe, the organizers thought, to look very closely at events prior to their arrival at the earth, including their origin.

What gives these particles the extremely high energies at which they travel with speeds very nearly that of light? This problem was—and unfortunately still is—largely unsolved. But to discuss it intelligently the time was divided as follows: two days on the observed energy distribution and the percentage of nuclei heavier than protons in the primary cosmic rays, two days on the time variations, and two days on the origin theories and related astronomical matters.

The time variations are important, for they may be correlated with the occurrence of single events like solar flares or with periods such as the solar day, the sidereal day, the 27-day rotation of the sun, the year, and the 11-year cycle of solar activity. The trouble is that most of these effects are present in small amounts, and are very hard to interpret. The daily and yearly changes are clearly mixed up with meteorological changes in the upper atmosphere of the earth. The 27-day and 11-year periods may be affected by changes in the magnetic conditions of the gas between the planets, which may change the number of received cosmic ray particles without affecting their origin. Only the occurrence of marked cosmic ray increases at the time of solar flares is well established and proves that, at least at those times and for half a day following, part of the recorded cosmic ray energy has originated on the sun.

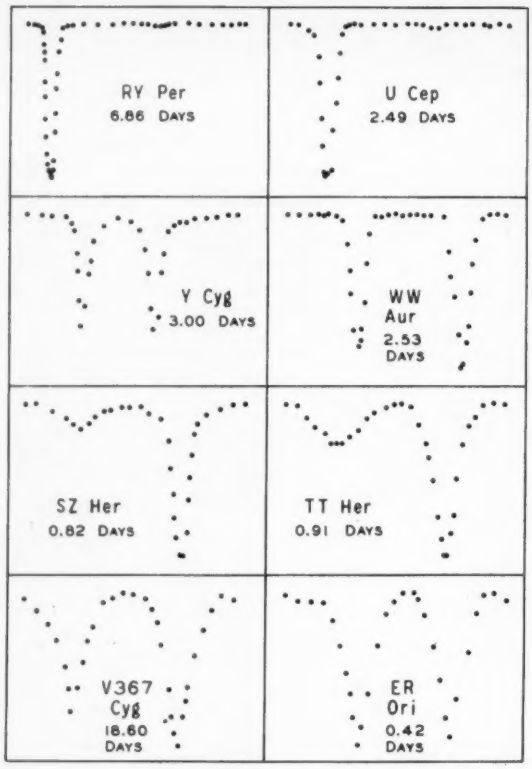
We should like to find a clear variation with sidereal time. Then we could start to sketch on a star map where most of the cosmic rays come from. But unfortunately no such effect is found. Also the efforts to map the sky by means of cosmic ray telescopes, which are sensitive to radiation from a selected region of the sky, revealed nothing but an evenly distributed radiation. Y. Sekido reported having found a "point source," but this case is doubtful as the peak barely exceeds the statistical fluctuations and as he found it in an energy range (10^{12} electron volts) where it would be least expected. Ingenious studies of the "map of the sky" at primary energies near 10^{15} or 10^{16} electron volts, which may be detected by means of the so-called extended showers, were reported by Miss P. Rothwell, by George Clark, and by J. Daudin, but a significant deviation from uniformity has not been found.

The reason undoubtedly is in the magnetic fields that are present everywhere near the earth, near the sun, in interplanetary space, in interstellar space, and perhaps even beyond the borders of our galaxy. All of these fields deflect the cosmic ray particles and make them run in narrow circles and spirals. Hence the direction of its original source cannot be recognized by the time a particle is detected. Only the particles of extremely high energy might offer hope, but they are so rare that an extensive study is quite difficult.

The last days thus started with little that was of a positive nature. The most certain fact is that the total energy reaching the earth due to cosmic rays is considerable. It is about equal to that in the form of starlight. Any theory is unacceptable unless it can give a sufficiently strong energy source and quite an effective mechanism for speeding up protons and other particles. So most speakers had to draw eventually on the source of nuclear energy in the stars. Nevertheless, a wide variety of suggestions remained. Theories were put forward with fervor and attacked with even sharper arguments. H. Alfvén put the origin in the sun, Unsold in the infrared flare stars, Blackett in magnetic stars, Oort in supernovae, Chandrasekhar in interstellar space, and Jean Heidmann in intergalactic space. A unified picture could not be drawn.

Oort's report on the observation of polarized light from the Crab nebula (see page 25 last month) made a great impression; it proves almost certainly that electrons with cosmic ray energies have been produced and are being produced in the supernova that made this nebula. Blackett's closing comment on this paper was: "We have tried very hard to find acceleration mechanisms, and almost invariably they do not work or have a low efficiency. Yet here before our eyes, in the Crab nebula, nature has invented a highly efficient machine that generates cosmic ray energies continuously and we do not know how!"

H. C. VAN DE HULST
Leiden Observatory



Light variations of some eclipsing variable stars, from estimates on Harvard patrol photographs discussed by S. Gaposchkin. Adapted from "Annals" of Harvard Observatory, Vol. 113, No. 2, 1953.

The Evolution of Close Binary Stars

Otto Struve, *Leuschner Observatory*
University of California

MANY ASTRONOMERS feel that the most informative stars in the sky are those belonging to close binary systems—pairs of stars in rapid orbital motion, whose separation is only of the order of the dimensions of the component stars themselves. The most interesting of these binaries have orbits that are nearly edge on, so the components can eclipse each other. In such cases, combining the spectroscopically determined orbit with the information obtained by analyzing the light curve can give a wealth of data on the sizes, shapes, masses, temperatures, and internal structure of the component stars.

An indication of the variety of these eclipsing double stars is afforded by the light curves of some representative systems shown above. These curves are selected from among 281 published by S. Gaposchkin, derived from Harvard Observatory photographs. A complete cycle is shown for each variable, but the magnitude scales are not the same, to allow for their quite different ranges; thus the variation of U Cephei is 2.8 magnitudes and that of Y Cygni only 0.6 magnitude.

In the top row, RY Persei and U Cephei both have deep primary eclipses and shallow secondaries. The minima of the former star are pointed and of the latter flat-bottomed, indicating partial and total eclipses respectively.

Y Cygni and WW Aurigae, in the second row, are instances of eclipsing pairs whose principal and secondary minima are practically identical, showing that each of these systems is made up of similar stars.

In eclipsing binaries where the components are nearly in contact, the stars are tidally elongated, and this gives rise to rounded light curves, such as shown for SZ Herculis and TT Herculis. Two cases of this kind, where the light curve displays nearly equal minima, are V367 Cygni and ER Orionis. The latter, with its period of about half a day, is a typical eclipsing system of the W Ursae Majoris type.

Recently, such pairs of stars have begun to yield even more significant information. Five important developments during the past 10 years have thrown new light upon the evolution of close binary systems.

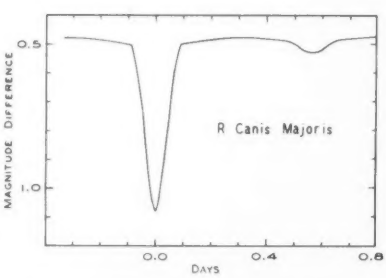


Fig. 1. The light curve of R Canis Majoris, from F. B. Wood's photoelectric observations. Ordinates give magnitude relative to the comparison star used by him. The primary (deep) minimum occurs when the star of greater surface brightness is eclipsed, and the secondary minimum when this star is in front of the fainter component of the system.

I. The first, in 1946, was F. B. Wood's work on R Canis Majoris, an eclipsing system with a period of 1.136 days. The brighter component—the only one whose spectrum is recorded—appears to be a normal star of spectral class *A*9. The eclipse is partial and has a depth of 0.6 magnitude and a duration of four hours. The light curve (Fig. 1) reveals that the radius of each component is about one quarter of the distance separating the centers of the two stars.

The spectroscopic velocity curve of the brighter component shows that star's orbital speed around the *center of gravity* of the system to be 24 kilometers per second. Since there are about 100,000 seconds in one revolution, the circumference of the brighter star's orbit is about 2,400,000 kilometers and the radius of its orbit is nearly 400,000 kilometers.

In order to determine the separation of the stars, we must first know the ratio of their masses. From the fact that the visible primary star has a normal *A*9 spectrum, we can infer that its mass is about two times that of the sun. The mass of the secondary must be such that it keeps the primary revolving at the observed rate of 24 kilometers per second around the common center of gravity. Furthermore, we know from Kepler's third law that the total mass of the system is equal to the cube of the orbital radius divided by the square of the period, where these quantities are expressed in terms of the sun's mass, the astronomical unit, and the year, respectively. We proceed with a calculation similar to that on page 700 of *Astronomy*, Vol. II, Russell, Dugan and Stewart.

The result is 0.2 solar mass for the second star. The mass ratio is therefore $2.0/0.2 = 10$, so the fainter component moves around the center of gravity in an

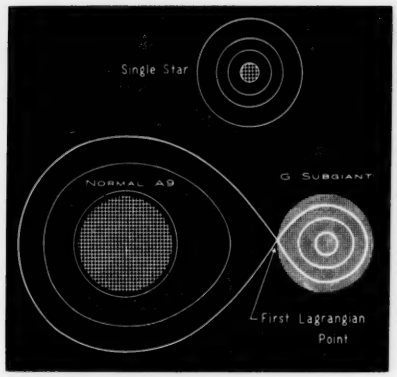


Fig. 2. Examples of zero-velocity surfaces around a single star, and around the close binary R Canis Majoris. Each surface shows how far matter, ejected with a given velocity from the star, will rise before falling back. The G component of the binary extends outside its critical zero-velocity surface; hence this star is unstable.

orbit of 4,000,000 kilometers radius. Hence, the separation between the centers of the stars is 4,400,000 kilometers, and the radius of each component is about one quarter of this, on the order of 1,100,000 kilometers. (The sun's radius is about 700,000 kilometers.)

Wood noticed that this large size would make the less massive component unstable. To understand why this is so, we must consider briefly the dynamical problem of *zero-velocity surfaces*. The simplest case is that of a single star. A small mass ejected from its surface at less than the velocity of escape would fly to a certain height above the photosphere, where it would reach zero velocity on the appropriate zero-velocity surface (spherically shaped for a single star) and would then fall back upon the star.

But R Canis Majoris is a double star, and the components are relatively near each other. They distort each others' zero-velocity surfaces into the shapes shown in Fig. 2, those of the more massive component being larger than those of the secondary, for a particular velocity. A particle slowly ejected from the secondary would fly outward, reach the approximately spherical zero-velocity surface, and return to the star. But a faster-moving particle would reach a greater height, where the secondary's zero-velocity surfaces are oval-shaped in the direction of the primary star.

For a critical velocity of ejection, the surface has an hourglass shape, with its halves meeting at a point between the two components which is called the first Lagrangian point (L_1). It turns out that the large secondary component of R Canis Majoris more than fills that critical surface possessing the point L_1. Any particle outside this surface does not "know" to which component it really belongs. A small disturbance might force it to leave the secondary and travel around the primary, or even fall into it.

II. The second development, between 1945 and 1950, came from the work of Yerkes and McDonald astronomers. They found that in most cases a very close binary is embedded in a gaseous envelope which revolves around the system in the direction of the orbital motions of the component stars, as illustrated in Fig. 3. If we combine this picture with Fig. 2, we obtain, as a typical representation of a close binary, Fig. 4, which illustrates the eclipsing binary U Sagittae.

The more massive component, of spectral class *B*, does not fill its critical zero-velocity surface, and it is therefore stable. The less massive star, a subgiant *G* star, is very large, spreading outside its own surface of zero velocity possessing the first Lagrangian point. Gas, in the form of prominences ejected by this secondary, swirls around the system, being confined along the outer hourglass surfaces.

III. The third stage came in 1950, when Wood concluded that nearly all binaries having at least one unstable component—one that fills the critical loop of its zero-velocity surfaces—show changing periods, some increasing by a few seconds each year, some decreasing by similar amounts. Binaries in which both components are stable rarely have variable periods. Wood has shown in an ingenious manner how these variations may be explained.

Suppose that we are dealing with a binary whose components are each equal in mass to the sun. Let the period be two days. From Kepler's third law we find that the orbital radius (of the secondary star's orbit with reference to the primary) is 0.039 astronomical unit, or six million kilometers.

Now, assume that the period of this system has somehow been changed to two days plus one second, but the orbital radius remains exactly as before. Then, again from the application of Kepler's third law, we find that the total mass must be two solar masses less about 2/100,000 solar mass. In other words, if the binary loses by evolution about a thousandth of one per cent of its mass, without at the same time changing the size of its orbit, its period will increase by one second.

But the orbit usually does change when mass is lost in a binary system. Wood considered the case of prominences expelled from the forward-moving hemisphere of one of the two stars. The resulting recoil lessens the orbital speed of the star, causing it to come closer to its companion. The period, by Kepler's third law, also decreases. For example, if the loss of mass is, as above, 2/100,000 of the mass of the sun, and this material is expelled from the star at 300 kilometers a second, Wood finds that the period decreases by 16 seconds. If the prominences are expelled from the following side of the star, however, the period *increases* by 18 seconds. In this manner we can account for both increasing and decreasing periods.

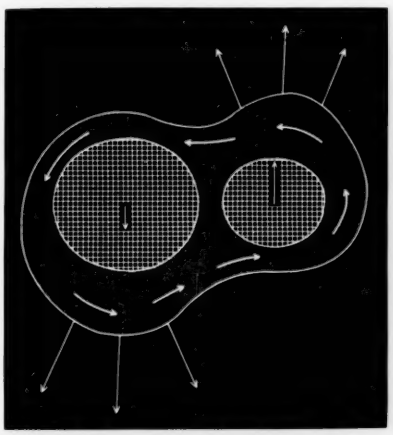


Fig. 3. Binary systems formed of two stars nearly in contact are in many cases enveloped in a cloud of gas, as shown schematically here. Arrows indicate motions of the gas streams. The two stars are elongated by tidal forces.

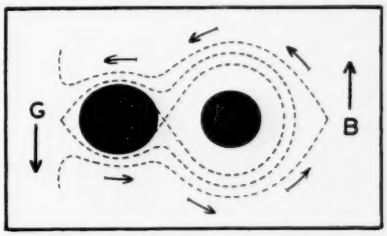


Fig. 4. The components of U Sagittae are embedded in a gas cloud that streams around both stars. This system has a total eclipse when the G star passes in front of the B star.

S. S. Huang, in an unpublished article, has recently extended the dynamical theory to explain all possible kinds of ejection, as well as capture of the ejected material by the other component. He has applied this theory to Beta Lyrae, whose period of nearly 13 days increases at the rate of about 9.4 seconds per year, according to Z. Kopal. If the mass of the principal component is 50 times the sun's, this change in period requires a loss of mass of 3×10^{22} grams per second. At this rate Beta Lyrae would exhaust most of its mass in 100,000 years; but undoubtedly it will, long before that, have become an entirely different kind of star.

Fig. 5 shows the latest attempt to interpret the spectrographic observations of Beta Lyrae. Roughly, we can think of the two violent gas streams in this system as pushing the components apart. This would act to increase the orbital radius, and hence also the period. The gas streams gradually diffuse into a large, disk-shaped nebula which expands outward. The material is ultimately lost in

interstellar space, so the total mass of the system is diminishing.

IV. The fourth, fundamentally new idea in our problem occurred simultaneously to J. A. Crawford at Berkeley and to Kopal at Manchester. It was known that nuclear evolution, resulting from the conversion of hydrogen into helium, carries single main-sequence stars across the Hertzsprung-Russell diagram along certain tracks. One of these (Fig. 6) was illustrated in our article on Nova Herculis in May, 1955. A star in this thermonuclear stage becomes more luminous as time goes on, and its surface temperature decreases, until about a billion years later it reaches the red giant stage. Its later development, when hydrogen is mostly exhausted, carries the star back toward the left of the diagram, into the region of the pulsating variables of the RR Lyrae type, and finally into the white dwarf stage, according to our present beliefs.

In the thermonuclear stage the star grows in size. We have already discussed this phenomenon in connection with the problem of stellar rotation, last month. Let us consider the particular star whose evolutionary track is shown in Fig. 6. When it is on the main sequence its spectral type is *F*, its surface temperature about 7,500°, and its absolute magnitude +3. A few hundred million years later its spectral type will be *G* and its surface temperature about 6,000°. Then every square centimeter of the star's surface will emit about $(7{,}500/6{,}000)^4 = 2.4$ times *less* light than before. But the star in the later stage will be about one magnitude or $2\frac{1}{2}$ times more luminous. Hence, its surface area must have increased by a factor of $2.5 \times 2.4 = 6$, and the radius by the square root of 6, or about $2\frac{1}{2}$.

Both Crawford and Kopal reason that if this *F*-type star, in its initial main-sequence stage, was the hotter and more massive component of a close binary system, and if this star already very nearly filled its critical zero-velocity loop, it would spill over the loop in the course of its evolution. It would then lose material in the form of gaseous streams or prominences, and thus gradually become less massive than its cooler companion. The latter originally had the lesser mass, but this condition would change as the primary star evolved.

As the primary star continually loses mass, its zero-velocity loop also contracts, resulting in a further and more copious spilling-over. As this process continues, the companion—a star whose nuclear evolution supposedly proceeds at a slower rate—would also begin to expand. Finally it, too, would begin to spill over its own zero-velocity loop, and we might then observe a binary like Beta Lyrae, in which both components are unstable, shedding matter in the form of the two streams depicted in Fig. 5.

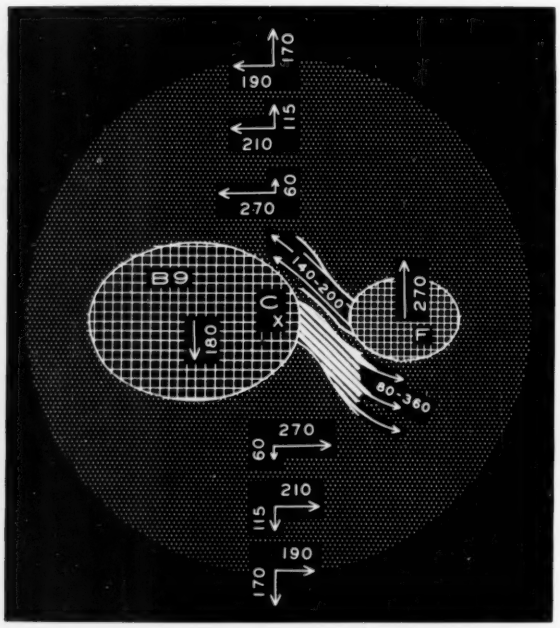


Fig. 5. A schematic representation of the Beta Lyrae system. The center of gravity (C) lies within the B9 star, from which gas is streaming. The arrows are labeled with velocities in kilometers per second. The expanding gas does not have a sharp boundary, as would appear from the diagram, but diffuses off into space.

V. The last and perhaps most inspiring development comes from Huang. Of necessity, his discussion of the evolutionary tracks of unstable double star components is still somewhat speculative. These tracks are represented schematically in Fig. 7. The evolutionary track of a single star is shown by the solid curve copied from Fig. 6.

A binary component will at first evolve along this track, until it begins to spill over its zero-velocity surface. It then loses mass rapidly, partly into space and per-

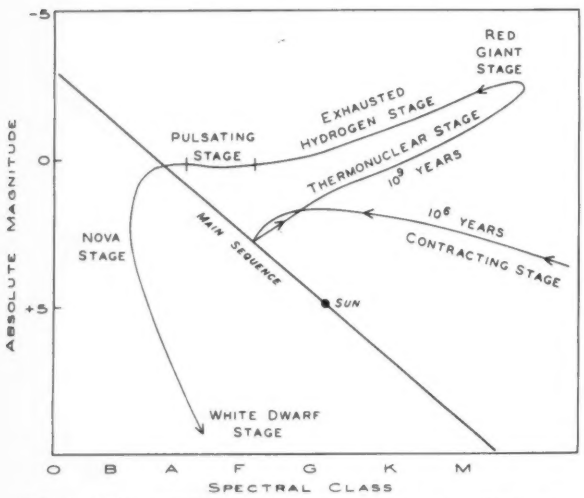


Fig. 6. The proposed evolutionary path of a single star that contracts to reach the main sequence at spectral type F, where thermonuclear processes begin to operate.

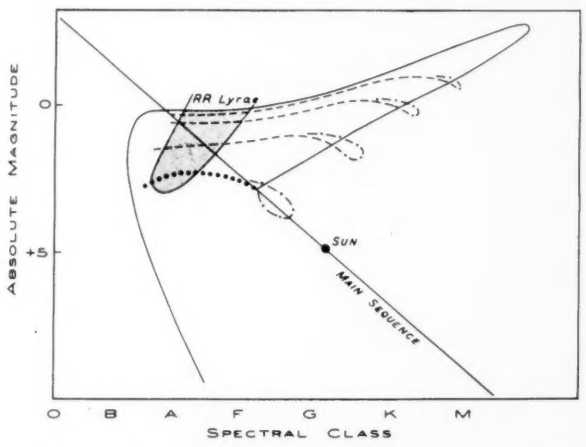


Fig. 7. Some probable evolutionary tracks of close binary stars, according to Huang. The shaded area indicates the pulsating stage, at the top of which the RR Lyrae variables are found. Below them in the shaded area are dwarf Cepheids, SS Cygni stars, and novae.

haps partly into its companion. Its evolution will then be altered. It may become hotter because of the removal of its surface layers, but without much change in luminosity. If so, it will turn to the left on the diagram long before it reaches the red giant stage. But it may also describe a more complicated loop, as shown in the diagram.

This loop stage of gravitational evolution lasts only a relatively short time.

But presumably the nuclear processes inside the star continue to reduce its hydrogen content, and as soon as the central temperature becomes high enough to convert helium into heavier elements the luminosity will again increase. Eventually, the track will turn to the left—essentially as in a single star—but these tracks and their loops lie below the track of a single star having the same original mass. And in the extreme case of a binary whose components nearly touch when both are on the main sequence, the evolution may never proceed to the right of the main sequence, following instead the track shown by the dots.

Huang suggests that only single stars, which evolve along the outside, solid track, become variable stars of the RR Lyrae type. However, it is reasonable to suppose that the same type of pulsation that induces the modest and strictly periodic puffs in single RR Lyrae stars may produce more violent outbursts in the unstable components of close binaries. Thus, the SS Cygni stars and the novae would occur along the lower tracks in Fig. 7, and would not represent a later stage of evolution of a single star. We have already seen that Nova Herculis is a very close double star, and we suggested in our article on this subject last May that perhaps all novae are similar close binaries. According to M. Walker, the masses of both components of Nova Herculis are about 1/100 of the sun's mass, and their

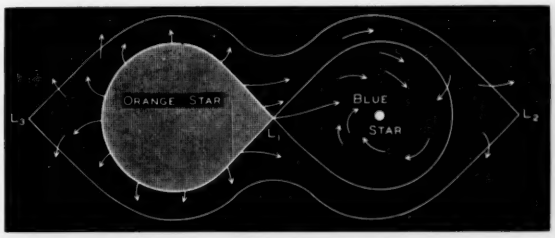


Fig. 8. AE Aquarii and the Lagrangian points associated with it, showing the motions of gases in the envelope surrounding the stars.

Planetarium Notes

(Most planetariums give group and special showings by appointment.)

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: Monday and Friday (Sept.-June), 3:45 p.m.; Thursday, 7:15, 7:45, 9:00 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sunday, 2:00 to 4:30 p.m. Admission free. Spitz projector.

CHAPEL HILL: *Morehead Planetarium.* Univ. of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; also 11 a.m. and 3 p.m. Saturdays, 3 and 4 p.m. Sundays. Zeiss projector. Manager, A. F. Jenzano.

CHARLESTON, W. VA.: *Hillis Townsend Planetarium.* Public Library Building, Charleston, W. Va.

SCHEDULE: Saturday, 11:15 a.m. Admission free. Spitz projector. Director, Louise L. Morlang.

CHEROKEE, IA.: *Sanford Museum Planetarium.* Sanford Museum, 117 E. Willow St., Cherokee, Ia.

SCHEDULE: Monday, 8 p.m. (except August). Admission free. Spitz projector. Director, W. D. Frankforter.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 2-1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Tuesdays and Fridays, 8 p.m.; Sundays, 2 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

DALLAS: *Dallas Planetarium.* Dallas Museum of Fine Arts, State Fair Park, Dallas, Tex., LO-5663.

SCHEDULE: Saturday, 11 a.m.; Sunday, 3 and 4 p.m. Spitz projector. Director, Mrs. Claudia Robinson.

FT. WORTH: *Charlie M. Noble Planetarium.* Ft. Worth Children's Museum, 1501 Montgomery St., Ft. Worth, Tex., PA-1461.

SCHEDULE: Tuesday and Thursday, 4 p.m.; Saturday, 10:30, 11:30, 2, and 3; Sunday, 2, 3, and 4 p.m. Spitz projector. Director, William Hassler.

INDIANAPOLIS: *Holcomb Planetarium.* Butler University, Indianapolis 7, Ind.

SCHEDULE: Saturday and Sunday, 4 and 8 p.m. Spitz projector. Director, Harry E. Crull.

KANSAS CITY: *Kansas City Museum Planetarium.* 3218 Gladstone Blvd., Kansas City 23, Mo., Humboldt 8000.

SCHEDULE: Saturday, 3:00 p.m.; 2nd and 3rd Sundays, 3:00 and 4:30 p.m. Spitz projector. Director, Kenneth W. Prescott.

LAQUEY, MO.: *Tarbell Planetarium.* Inca Cave Park, Laquey, Mo.

SCHEDULE: Daily, 1 to 6 p.m., continuous. Spitz projector. Director, E. D. Tarbell.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 27787, Los Feliz Station, Los Angeles 27, Calif., Normandy 4-1191.

SCHEDULE: Wednesday, Thursday, and Friday at 8:30 p.m.; Saturday and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

MINNEAPOLIS: *Science Museum.* Minneapolis Public Library, 1001 Hennepin Ave., Minneapolis 3, Minn.

SCHEDULE: Saturday, 10 a.m. and 2 p.m. Admission free. Spitz projector. Curator of education, Maxine L. Begin.

NASHVILLE: *Sudekum Planetarium.* Children's Museum, 724 2nd Ave. S., Nashville 10, Tenn., 42-1858.

SCHEDULE: Sunday, 2:45, 3:30, 4:15. Spitz projector. Associate curator of education, Burton Ingram.

NEWARK: *Newark Museum Planetarium.* 49 Washington St., Newark 1, N. J., Mitchell 2-0011.

SCHEDULE: Saturday and Sunday, 2:30 and 3:30 p.m. Admission free. Spitz projector. In charge, Ray Stein.

NEW YORK CITY: *American Museum—Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Trafalgar 3-1300.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 1, 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 1, 2, 3, 4, 5, and 8:30 p.m. Zeiss projector. General manager, J. M. Chamberlain.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 1-4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 4:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

PORTLAND, ORE.: *Oregon Museum of Science and Industry Planetarium.* 908 N.E. Hassalo St., Portland 12, Ore., East 3807.

SCHEDULE: Saturday and Sunday, 3:00 p.m. Spitz projector. Director, Stanley H. Shirk.

PROVIDENCE: *Roger Williams Planetarium.* Roger Williams Park Museum, Providence 5, R. I., Williams 1-5640.

SCHEDULE: Saturdays, Sundays, and holidays, 3 and 4 p.m. Admission free. Spitz projector. Director, Maribelle Cormack.

SAN FRANCISCO: *Morrison Planetarium.* California Academy of Sciences, Golden Gate Park, San Francisco 18, Calif., Bayview 1-5100.

SCHEDULE: Daily (except Monday and Tuesday) at 3:30 and 8:15 p.m.; also at 2 p.m. on Saturdays, Sundays, and holidays. Academy projector. Curator, George W. Bunton.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8:30 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, F. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Sunday at 4:00 p.m. Admission free. Spitz projector. Director, Ernest T. Luhde.

sizes are about 1/10 of the sun's. These stars are thus probably about 10 times denser than the sun.

SS Cygni itself and AE Aquarii have both been found by A. H. Joy to be close binary systems. These stars show moderate novalike outbursts at fairly frequent intervals. A recent study by Crawford and R. P. Kraft shows that the outbursts of AE Aquarii may be explained by the instability of the large *K* star, part of the expelled gas being captured by the small blue star (Fig. 8).

Huang's hypothesis has many attractive features. Let us mention only a few of them:

a. It has been known for a long time that the novae are not high-velocity stars like the RR Lyrae variables. Hence, they cannot have evolved from the latter. Moreover, their distribution in the galaxy and in other stellar systems is not at all like that of the cluster-type variables. They are undoubtedly older in an evolutionary sense but younger, in years, than RR Lyrae stars, whose evolution has not been accelerated by loss of mass. Huang's diagram shows that the novae must be older, in both respects, than main-sequence stars.

At this point, it would be well for the reader to turn to page 278 of the May issue to see how Huang's work has very recently changed our thinking. No longer can we apply the evolutionary track shown there (Fig. 6 in the present article) to the life history of a nova, if such stars all turn out to be binaries.

b. On the other hand, there are no known close binaries among the RR Lyrae variables. It is reasonable to believe that they are single stars that have developed along the solid-line track of Fig. 6 to the region marked "pulsating stage."

c. According to Huang, a single star of smaller mass than RR Lyrae should evolve along a track that reaches the shaded region of pulsational instability (Fig. 7) at a lower luminosity than RR Lyrae. Actually, we know from our articles in August and September that there are such variables; we have called them dwarf Cepheids.

d. We do not observe single stars along the dotted-line track of Fig. 7. This may be because our Milky Way galaxy is not old enough to contain single stars with masses as small as those of the novae, that have evolved, solely by nuclear processes, far away from the main sequence. In fact, we believe that even the oldest formations in our galaxy, the globular clusters, contain stars (with masses not exceeding the sun's) that are still on the main sequence. In five billion years or so, they have used up only an insignificant fraction of their original hydrogen content. The life expectancy of the sun, for example, is of the order of 100 billion years. No wonder, then, that in our galaxy the sun has not had enough time to reach the pulsating stage of its evolution.

Amateur Astronomers

Variable Star Observers Hold 44th Fall Meeting

LOOKING BACK on a year of great observational activity as they enjoyed a full program, nearly 50 members of the American Association of Variable Star Observers met at Springfield, Mass., on the weekend of October 21st, as guests of the Springfield Museum of Natural History.

The opening attractions of the meeting were the lecture by Prof. C. L. Stearns, Van Vleck Observatory, on how distances of the stars are determined, and a special demonstration of the museum's Korkosz planetarium.

At the business meeting, Mrs. Margaret W. Mayall, the AAVSO recorder, reported that in the year ended on September 30th a total of 64,990 variable star observations were made by 144 AAVSO observers in 20 countries. The two leading individuals were R. de Kock, of South Africa, and E. Oravec, Tuckahoe, N. Y., who made 5,977 and 4,843 estimates, respectively. Particularly noteworthy was the record of the observing group of the New York Amateur Astronomers Association, which contributed some 21,000 observations, mainly of brighter variables.

H. L. Bondy told of activities of the Solar Division. The American sunspot numbers are now based on the reports of some 60 active observers. New observing programs are planned for sunspot evolution, special spot phenomena, and radio observations of solar flares. In other divisions of the AAVSO, 84 occultations of stars by the moon were timed by members during the past year, and a new committee on photoelectric photometry has become active under the chairmanship of Lewis J. Boss, of San Francisco. The committee is preparing a manual for amateur photoelectric observers.

At the session for scientific papers, Mr. Oravec reported a new irregular variable in the constellation Lepus, EB 120. Intensive visual observations since 1948 show light changes between magnitudes 5.9 and 7.0. J. J. Ruiz exhibited his photoelectric light curve of the eclipsing variable u Herculis. Algol observations were reported by J. Knowles, and Clinton Ford told of his statistical analysis of the light curves of the long-period variables R Cygni and RT Cygni.

Other papers included Mr. Bondy's account of solar flares, and illustrated reports of visits to Australian and British observatories by Mrs. Martha Stahr Carpenter and by C. A. Federer, Jr., respectively.

At the AAVSO banquet, Dr. Harlow Shapley, of Harvard Observatory, listed the astronomical highlights of the past year. Two dealt with artificial satellites: the announcement of American government support of a satellite project for 1957-58, and the legal problem of ownership of the upper atmosphere. Four of the others also concerned the solar system: the definite identification by W. O. Roberts and D. Layzer of the yellow coronal line as due to calcium XV, calcium atoms that have lost 14 of their 20 electrons; the long total eclipse of the sun on June 20, 1955; the results from intensive observations of Mars during its favorable opposition in 1954; and the unexpected discovery of intense radio emission from Jupiter.

Others of the highlights concerned stars and stellar systems. These were the direct observation of the star of smallest known mass, Ross 614B, with the 200-inch telescope; the completion of Harvard's 50-year program of study of variable stars in the Magellanic Clouds; C. F. von Weizsaecker's interpretation of the evolution of globular star clusters; and the appearance of the first installment of the National Geographic-Palomar sky atlas, from photographs with the 48-inch Palomar Schmidt telescope.

The closing feature of the meeting was a visit to Mr. Ford's well-equipped observatory at Suffield, Conn., where clear skies permitted observations with his 10-inch reflector. Mr. Ford exhibited his photoelectric photometer.

Officers of the AAVSO for the coming year are C. Fernald, Wilton, Me., president; R. Hamilton, Darien, Conn., and R. Buckstaff, Oshkosh, Wis., vice-presidents. Continuing in their offices are Mr. Ford, secretary; P. Witherell, Jamaica Plain, Mass., treasurer; and Mrs. Mayall, Cambridge, Mass., recorder.

J. A.

ROCKY MOUNTAIN CONFERENCE

REGISTRATION for the Denver conference of amateur astronomers this fall began at the Chamberlin Observatory, University of Denver, on Friday afternoon, September 9th. There were varied activities during the evening. The 20-inch Chamberlin refractor was in constant use, with Thomas J. Bartlett, of the observatory staff, at the controls. E. D. Onstott, Pueblo Astronomical Society, had the delegates intrigued with his motorized Spitz Junior planetarium. In the lecture room a movie, The Frontiers of Space, took care of anyone who was momentarily unoccupied. Telescopes set up for observing included instruments of the Denver Astronomical Society, our host group, and from Pueblo and Cheyenne as well.

At the Saturday morning session, Mr. Bartlett spoke on interstellar dust, a subject on which he has done considerable research. Vernon Goerke, a member of the Boulder Astronomical Society, described the National Bureau of Standards

radio astronomy installation at Gunbarrel Hill. He showed several models of the various instruments being erected there.

Oscar Magnusson and Ray Kramer, of Denver, gave instructive talks on telescope making and metal casting. In the afternoon W. R. Van Nattan, also of Denver, reported on the joint project of the Denver and Boulder societies to photograph the Perseid meteor shower, with the help of the Denver Radio Club. Other such ventures, more detailed and extensive, are scheduled for the future.

During the afternoon session, a committee was established to set up a working plan for the formation of a Rocky Mountain area association. Mr. Onstott was elected chairman, with the other committee members to be Dr. Lynwood Hopple, Denver; James Johnston, Boulder; and George Doran, Cheyenne.

In the late afternoon, we divided into two groups, one going to Boulder to inspect the astronomical gadgetry of Mr. Goerke's radio telescopes, the others taking a tour of Denver instruments, including Mr. Kramer's 16-inch.

Dr. E. A. Fath, as banquet guest speaker, discussed contributions of famous amateurs to astronomy. Dr. Fath is retired director of Goodsell Observatory, Carleton College. About 60 people attended.

KENNETH STEINMETZ
1680 W. Hoye Pl.
Denver 23, Colo.

JOINT REGIONAL CONVENTION IN LOUISVILLE

THE Middle East and Great Lakes regions of the Astronomical League held a joint convention in Louisville, Ky., over the Labor Day weekend, on the campus of the Baptist Theological Seminary. Eighty-nine persons attended the two-day meeting. Friday evening the Louisville Astronomical Society, convention host, sponsored a get-acquainted period.

Saturday's business included the roll call of societies, committee reports, and the election of officers. Chosen for the Great Lakes Region are Charles Johnson, Detroit, chairman; William Garnatz, Indianapolis, vice-chairman; Mrs. Olive Grunow, Detroit, secretary; and Charles Strull, Louisville, treasurer. For the Middle East Region new officers are Elizabeth Fazekas, Washington, D. C., chairman; Adam Ott, Pittsburgh, vice-chairman; Mrs. Ione Alston, Washington, secretary; Aubrey Hustead, Norfolk, treasurer.

Program highlights were the mirror-silvering demonstration by Louis Aker, of Louisville; a very stimulating junior session led by Clarence Johnson, Schenectady, N. Y., Astronomical League chairman of junior activities; an interesting demonstration by G. R. Wright, Washington, on a new method of projecting astronomical subjects; an inspection tour of the Miller Observatory of the University of Louisville; and remarks by Grace C. Scholz, Astronomical League president, on "What you can do for the league, and what the league can do for you."

Sunday evening's program was in connection with the dedication of the Moore Observatory, housing a 20-inch reflecting telescope made by members of the Louisville Astronomical Society over the past 15 years. This installation is at the suburban home of Dr. W. L. Moore, of the University of Louisville. Observing with the new instrument concluded the evening's activities.

ELIZABETH FAZEKAS
2621 Garfield St. N. W.
Washington 8, D. C.

OHIO OBSERVATORY REOPENED

CLARKE Memorial Observatory at Mount Union College, Alliance, Ohio, has been reopened following a two-year renovation of the 9½-inch refractor and its housing. Before September, 1952, when the work began, the observatory had been idle for approximately 12 years. (The earlier history of this instrument was told by Hilda M. Hequembourg in January, 1952, page 57.)

The project was carried out by Prof. James P. Rodman, director of the observatory. Assisting him were Dr. William A. Rice, Walter Webb, Jr., the undersigned, and others. Mr. Webb and I were undergraduates at Mount Union when the work began.

We replastered the walls of the building, poured a new concrete floor in place of the warped wooden structure, set new windows and frames, and restained the dome. We cleaned, calibrated, and assembled the lenses of the telescope. The rack-and-pinions were replaced, the telescope was rewired, and the vernier scales were refinished. Two 2¼-inch refractors, one a finder and the other a photographic guide telescope, were added. A camera-adapter unit, and a variable diaphragm in front of the objective lens, completed the additions. The estimated value of the instrument is approximately $35,000.

The observatory is now open every Thursday evening and on special occasions for unusual astronomical events. The general public is invited, and interested groups may contact Mr. Rodman at the college.

KEENE A. BRIDGEMAN
151 Sunset Drive
Williamsville 21, N. Y.

MEMPHIS, TENN.

The Memphis Astronomical Society now meets at the Memphis Museum, on the second Saturday of each month at 7:30 p.m. The society conducts free public lectures on the first Friday of each month. Four of the members present weekly lectures at our city planetarium. Information about Memphis activities may be had from Ned Lawrence, 3081 Chisca Ave.

THIS MONTH'S MEETINGS

Cambridge, Mass.: Bond Astronomical Club, 8 p.m., Harvard College Observatory. Dec. 1, Miss Miriam E. Dickey, children's night.

Cleveland, Ohio: Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. Dec. 9, Charles A. Federer, Jr., Harvard Observatory, "Astronomy in the Service of Man."

Geneva, Ill.: Fox Valley Astronomical Society, 8 p.m., Public Library. Dec. 13, Christmas party.

Long Beach, Calif.: Excelsior Telescope Club, 8 p.m., home of T. Cave, 265 Roswell Ave. Dec. 9, annual meeting.

Minneapolis, Minn.: Minneapolis Astronomy Club. Dec. 9, field trip, 8 p.m., old University of Minnesota airport.

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. Dec. 7, Dr. Louis C. Green, Haverford College, "Atoms, Stars and Computations."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Commerce Department auditorium. Dec. 3, Dr. J. S. Hall, U. S. Naval Observatory, "The Image Converter Program—A Great Advance in Astronomy."

DAYTON, OHIO

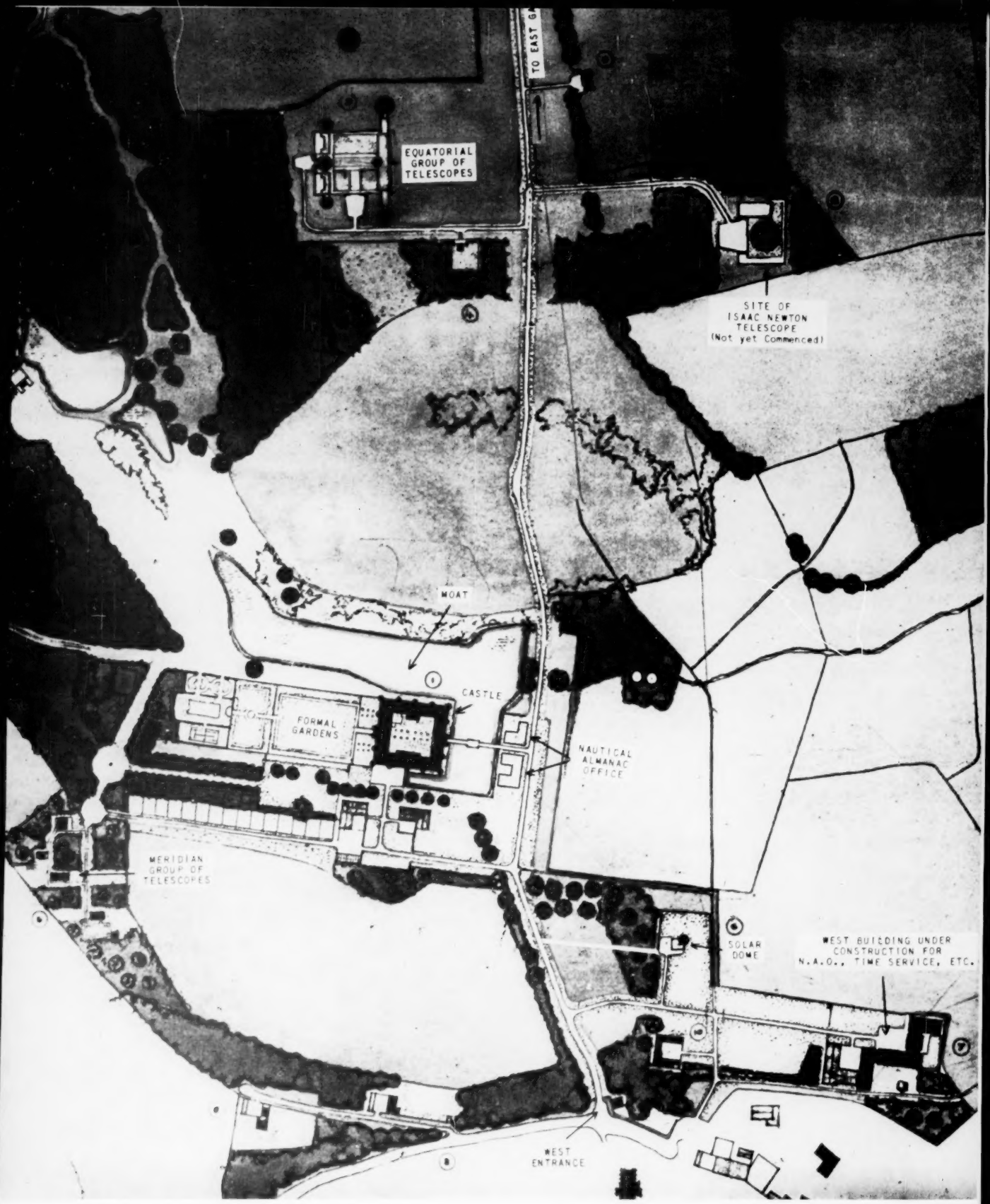
The former Amateur Telescope Makers of Dayton have been reactivated under the name of Miami Valley Astronomical Society, with 51 members this fall. Meetings are held at 8 p.m. the second Friday of every month at the Dayton Museum of Natural History, Patterson Blvd. and E. Second St. Amateur astronomers and telescope makers in the area are invited to attend meetings. F. E. Sutter, 5038 Dayton-Leonan Pike, Dayton 9, Ohio, can supply further information.

MIAMI, FLA.

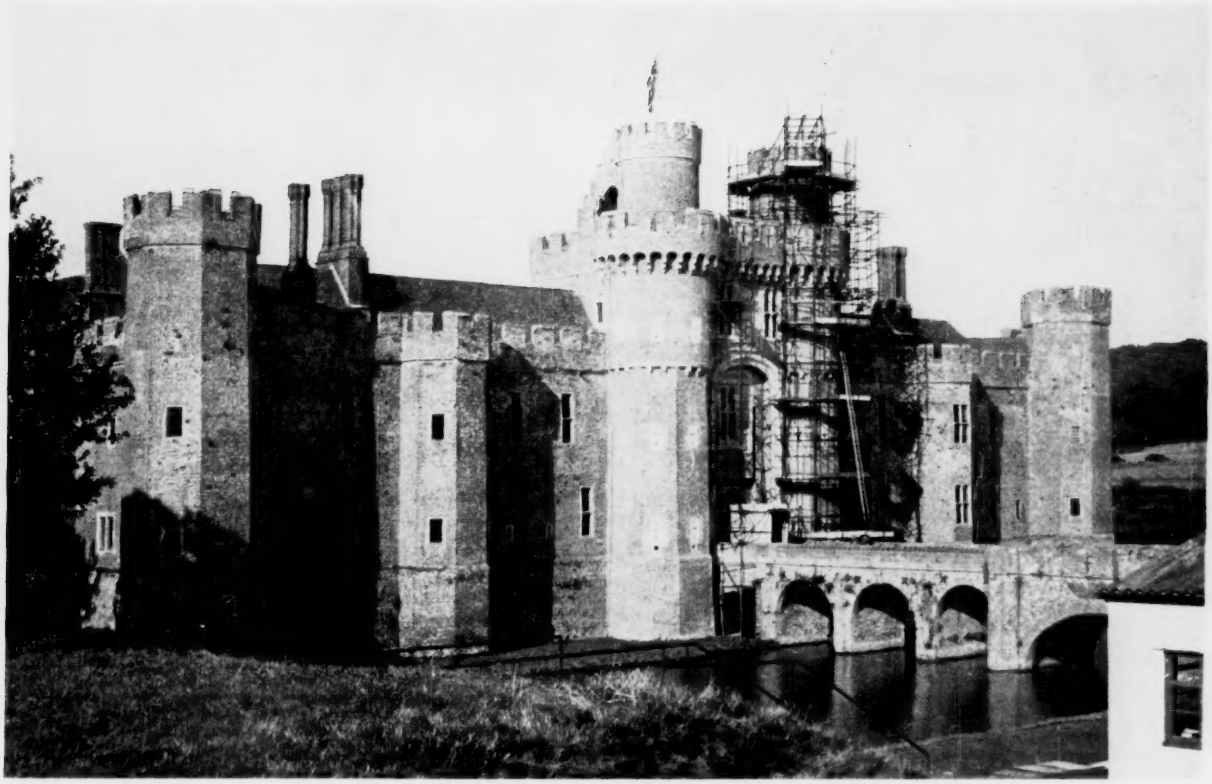
The Southern Cross Astronomical Society has moved to the Junior Museum of Miami, 1737 N. Bayshore Drive, from its old meeting place in the Central School in downtown Miami. At the new location the society will continue its program of free public lectures the third Monday of each month. Portable mountings are being used temporarily for the society's 5-inch Clark refractors at the museum.

The Junior Museum has a Spitz planetarium which will seat about 75 persons. As a group project, society members have contributed models and transparencies, telescopes, and other exhibits for the astronomy gallery.

Public observing conducted by the society continues weekly at the Miami Shores and Miami Beach libraries (*Sky and Telescope*, February, 1955, page 141). The secretary is Arthur P. Smith, Jr., 426 S.W. 26th Rd., Miami 36, Fla.



North is toward the left in this map showing the locations of the principal buildings of the Royal Greenwich Observatory at Herstmonceux, Sussex, England. The equatorial group of buildings toward the east is about one third of a mile from the castle.



The castle at Herstmonceux, as it appeared in August, with scaffolding erected for stonework on one of the towers.

PROGRESS AT HERSTMONCEUX

OPEN HOUSE days were held this summer by the Royal Greenwich Observatory both before and after the International Astronomical Union assembly in Dublin. Astronomers from all over the world visited the new site of the observatory at Herstmonceux Castle, in southeastern England.

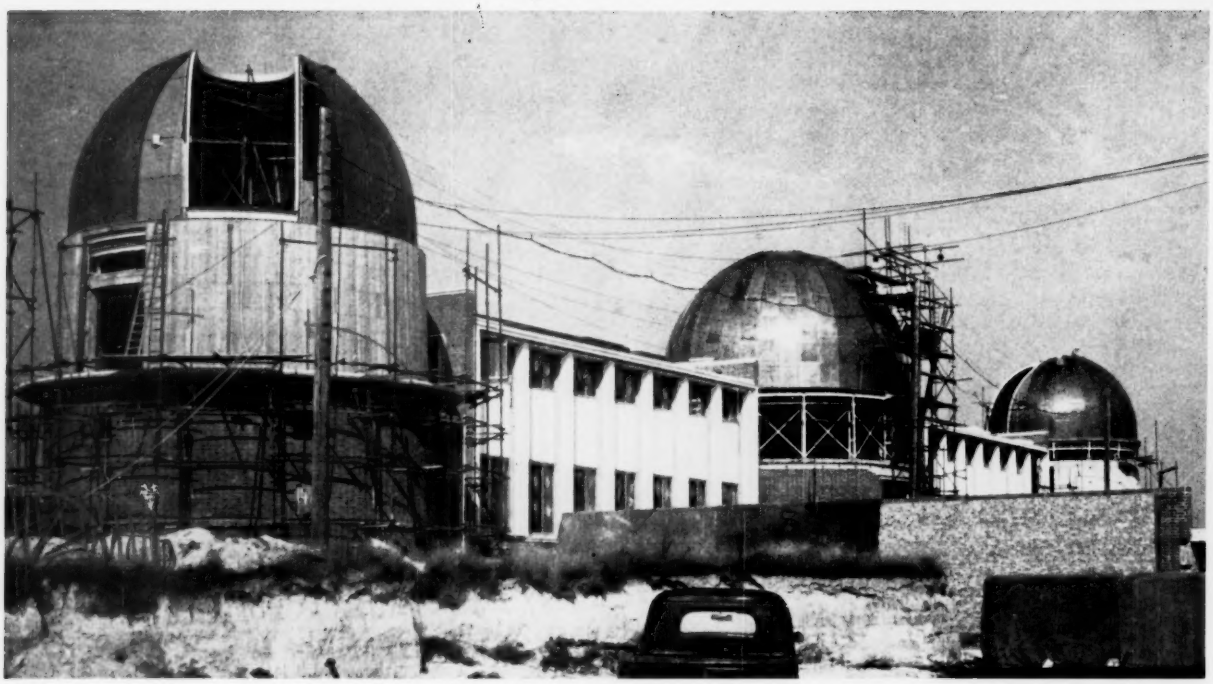
They saw the progress of work on the exterior of the castle, which was built in 1440 and has been called one of the most beautiful structures of its type in England. These exterior walls consist of the original brickwork. Even though the building had been renovated as a country mansion some years ago, the stonework of the gateway and towers had become badly weathered, and its replacement is just being completed.

The interior of the castle is converted into office space, and its great hall has become the observatory library. It was necessary to reconstruct the floor of the hall to support the weight of the books.

The great range in observational programs undertaken by the Royal Observatory is reflected by the numerous and varied instruments erected or planned for Herstmonceux. Already well under way is the group of six equatorial telescopes, situated together on the crest of the rise some distance east of the castle. The domes of four of these were nearing completion when the photographs illustrating this article were taken in August.

Three reflectors are to be housed in the large new astronomical office and laboratory building. In the most east-

Some of the visiting astronomers converse on the plaza in front of the castle. The buildings of the equatorial group are seen in the distance; on the following pages are larger photographs of four of the six domes in that group.



The front (south side) of the main equatorial building is seen here. The dome for the Schmidt is at the extreme right. The reflectors in the central and nearer dome will be able to "see" into each other over the flat roof.

ward dome there will be a large Schmidt telescope. The other domes are for a 30-inch reflector and the 36-inch Yapp Cassegrainian that is used for spectrographic observations of stars. These two domes are constructed and the instruments mounted so they can be pointed directly toward each other across the flat roof that separates them. Either telescope can thus be fed by the other with a nearly parallel beam of light for calibration work and other tests and operations.

The building will contain darkrooms, a plate-standardizing laboratory, and an aluminizing room and apparatus. For recoating, each of the three main reflector mirrors will be lowered through the floor of its chamber and then transported to the aluminizing room without encountering any steps.

At the southwest corner of the group of six instruments will stand the 26-inch photographic refractor used for stellar parallaxes; at the southeast corner will be the Greenwich 28-inch refractor, long employed for measurements of double stars. Between these instruments, in a smaller dome, the 13-inch astrographic refractor will continue its work on comet and asteroid positions.

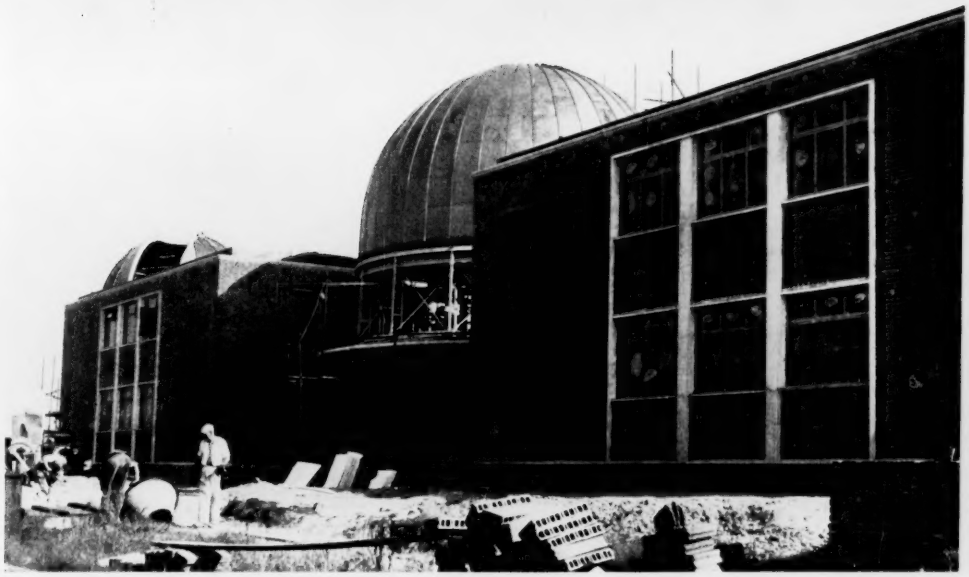
Impressive as this array of telescopes and their fields of service are, they represent only a single division of the observatory. The traditional work of the Royal Observatory has been transit-circle observations of the positions of the sun, moon, planets, and stars, and Herstmonceux is to be a world center in this work.

The group of buildings being erected northwest of the castle will house meridian instruments of modern design. Chief among these is the Cooke reversible transit telescope, which has six photographic microscopes by means of which each setting is read at six points around the circle. This instrument was in use at Greenwich alongside the historic Airy transit circle, before the latter was retired from service. Another building of the meridian group is for the transit circle previously used at the Melbourne Observatory in Australia.

The recently installed photographic zenith tube is the newest version of this important type of time-measuring instrument. It is fully automatic, operated by remote control from a nearby building to avoid any temperature disturbances that might be caused by the presence of an observer near the instrument.

Transfer of the Royal Observatory's diverse activities to Herstmonceux has been by gradual stages, partly because of the magnitude of the shift, and partly to

The 26-inch refractor will be housed under this dome. The mounting support has already been set on the pier.



This view of the main building of the equatorial group is taken from its north side, showing the central dome and, behind the east wing, a portion of the Schmidt dome.

avoid disruption of important programs. The Nautical Almanac staff has already been working at Herstmonceux for more than five years. Although one solar telescope has been in operation for several years, the solar spectrograph is being rebuilt. It will use a 10½-inch objective, into which the sun's light will be fed by a 16-inch coelostat.

For two years a continuous record of cosmic radiation has been made, together with earth magnetism and meteorological observations on a regular schedule. As an establishment of the British Admiralty, the observatory is responsible for testing of chronometers for the Royal Navy and Air Force. Visitors enjoyed demonstrations of test methods by staff members of the laboratory, through which well over 20,000 timepieces pass in a single year.

One very important activity not yet centralized at the new location is the time service. The observations for time determination continue to be made at Greenwich and at Abinger. On the map may be seen the location of a large building southwest of the castle, where several of the allied activities mentioned above will be housed. Until this structure is completed, the transfer of the time service to Herstmonceux cannot take place.

Observational astrophysics is of growing importance at the observatory, where the 98-inch Isaac Newton reflector is to be located. Construction has not been started, however, and present plans call for the completion of the rest of the observatory before this project is given a high priority. The mirror has been figured and awaits further testing. The sum of $33,000 was appropriated for development work on this instrument during the year beginning April, 1955.

The visiting astronomers were entertained at luncheon, and toured the castle grounds to inspect the buildings and instruments. They came away with the feeling that Herstmonceux Castle is serving the interests of science and of man in far more significant ways than had ever been imagined by its builders.

This view in the interior courtyard of the castle is toward the residence of the Astronomer Royal.

SECTION D TO MEET IN ATLANTA

At the Atlanta meeting of the American Association for the Advancement of Science, Section D (Astronomy) will convene on the afternoons of December 28th and 29th. Astronomers wishing to participate in the technical session Thursday should send their papers by December 10th to Dr. F. K. Edmondson, Indiana University, Bloomington, Ind., secretary of Section D.

The Wednesday session will hear talks by members of the Astronomical League, an affiliated society of the AAAS. Dr. William A. Calder, director of Bradley Observatory, Agnes Scott College, will speak on "Photoelectric Determination of the Albedo of the Moon."

The address of the retiring vice-president of Section D, G. M. Clemence, U. S. Naval Observatory, on "Standards of Time and Frequency," is scheduled for Thursday evening, December 29th.

An open house at Bradley Observatory on Friday evening, followed by a meeting of the Atlanta Astronomy Club, concludes the official program. At this meeting, Dr. Edmondson will talk on the Milky Way.

COLLEGE LECTURES IN NEW YORK PLANETARIUM

A diversified group of courses on astronomy, constellation study, navigation, and meteorology, is offered this fall and spring at the American Museum-Hayden Planetarium in New York City. Included in their listing is a lecture on "Planetarium Descriptive Astronomy—College Level," that is given by special arrangement on Thursdays.

A briefing on the physical nature of the solar system is presented by means of the Copernican planetarium (orrery), after which the Zeiss projector is used to study diurnal motion at various latitudes, motions of the sun, moon, and planets, precession, and co-ordinate systems. Designed for schools offering an introductory astronomy course or an astronomy unit, each lecture is adapted to the needs of the students, in consultation with their instructor.

NEWS NOTES

By Dorrit Hoffleit

WISCONSIN SOLAR ENERGY PROJECT

The Rockefeller Foundation has given $250,000 toward a four-year program at the University of Wisconsin for research on the utilization of solar energy. Twenty scientists from 10 different departments will collaborate in developing solar engines, irrigation pumps, solar operated refrigerators, and cookers. They will also work on long-range projects, including photosynthesis, photoelectricity, and the storage of electrical energy for large-scale use. Preliminary arrangements have already been made for field tests in several countries, especially under the primitive conditions where these devices would be of particular value.

The project is headed by Dr. Farrington Daniels, chairman of the department of chemistry at Wisconsin.

VARIABLE STARS IN GLOBULAR CLUSTERS

Variable stars of the cluster type, now generally called RR Lyrae stars, were originally found and identified in globular clusters. They are pulsating stars with periods averaging about half a day. The study of globular clusters for these and other types of variables continues to be of considerable astrophysical importance.

Helen B. Sawyer has just published *A Second Catalogue of Variable Stars in Globular Clusters*, as Vol. II, No. 2, of the *Publications* of David Dunlap Observatory. It lists 1,421 stars that change in brightness within the 72 globulars known to have been searched for such objects. This represents an increase of 329 variables, belonging to 46 clusters, since the publication of her first catalogue in 1939. Messier 3, in Canes Venatici, and Omega Centauri are the two clusters richest in variables, with 187 and 164 known, respectively. Messier 5, in Serpens, has 97 variables, and Messier 15, in Pegasus, has 93.

Periods have been determined for 843 variables in 38 clusters, in comparison with the 656 periods known in 1939. While most of the variables are typical RR Lyrae stars, 122 in 36 clusters represent almost all the other recognized types of variability. Probably many of these are foreground stars instead of cluster members.

Mrs. Sawyer-Hogg has pointed out that there may be two varieties of RR Lyrae stars in the globular clusters. The distribution of periods shows a gap near 0.45 day, as shown in the chart.

For 34 globulars, there is no published record of a search for variables. Nearly all of these clusters are in the far southern sky or are such difficult objects that only such large telescopes as the 100-inch can be used to study them.

WATCHING THE EARTH ROTATE

A new exhibit at New York's Hayden Planetarium enables visitors to observe the earth's rotation at the push of a button. It contains a large, high-speed gyroscope, which maintains a fixed axis with respect to space. A beam of light, caught by a mirror attached to the gyro and reflected by another mirror mounted on a nearby wall, appears to move along a graduated scale on the exhibit. This motion occurs because the scale and the building are carried by the earth's rotation, while the orientation of the mirror on the gyroscope is unaffected.

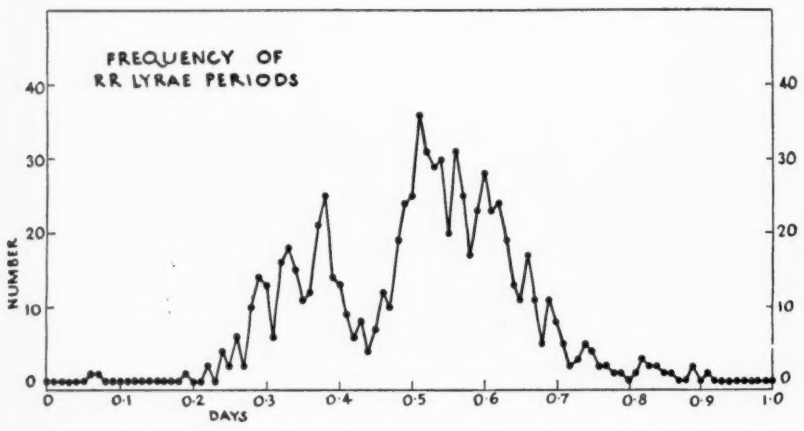
SUPERNOVAE AND THE RED SHIFT

A recurrent problem in astronomy is the interpretation of the red shift in the spectra of distant galaxies. Among the numerous theories that have been proposed, that of the expanding universe still seems the most promising. In the *Astrophysical Journal*, S. N. Milford, St. John's University, discusses three observational tests of the expansion hypothesis. One of these, which may be within the reach of existing instruments, involves the light curves of supernovae.

There are two main types of supernova. Type I reaches a maximum brightness about two or three magnitudes brighter than Type II. About 100 days after maximum light, when a Type I supernova has declined in brightness by about three magnitudes, a further steady decline sets in that is at the same rate for practically all such supernovae so far observed.

Dr. Milford suggests comparing the rates of decline in brightness of Type I supernovae beginning 100 days after maximum light. The expansion should make a supernova of Type I occurring in a very remote galaxy appear to fade more gradually than such a star in a nearby galaxy. The possibility of this method was pointed out by O. C. Wilson in 1939.

The other two tests proposed by Dr. Milford also involve the dilation of the time-scale of a distant galaxy that would appear if the universe is expanding. One effect would be that supernova outbursts should be less frequent in very remote galaxies. Furthermore, in distant stellar systems the periods of Cepheid variables should seem lengthened. Both of these tests are too difficult to make at present.



This chart is reproduced from the new catalogue of variable stars in globular clusters, by Helen B. Sawyer. It shows the number of periods at intervals of 0.01 day, for 781 RR Lyrae variables with known periods in 28 globular clusters. David Dunlap Observatory diagram.

IN THE CURRENT JOURNALS

THE GENERAL NEEDS OF ASTRONOMY, by Otto Struve. *Publications*, Astronomical Society of the Pacific, August, 1955. "We must find a way to attack not only those problems that are attractive to us, but also those laborious and often thankless jobs that are needed for the general advancement of our science."

THE PLANET EARTH, various authors. *Scientific American*, September, 1955. "During the Geophysical Year scientists of many disciplines will observe all the large-scale aspects of the earth: its interior, the oceans and glaciers, the lower and upper atmosphere, gravity and magnetism, and the extraterrestrial forces which profoundly influence these interacting features."

SCOTLAND YARD INVADES MEDIEVAL ASTRONOMY, by Garland Greever. *Griffith Observer*, September, 1955. "The book I shall tell you about [*The Equatorie of the Planetis*, edited by Derek J. Price] moves backward in time and sleuths in medieval astronomy. . . . the manuscript might well be a Chaucer holograph, the only composition of his known to have come down in his own writing."

Some Notes from the IAU Meeting

Planets and Satellites

STUDIES of the planets and satellites, apart from their motions, form the domain of Commission 16. Its president, G. P. Kuiper, Yerkes and McDonald Observatories, was able to report major advances since the IAU's meeting at Rome.

Among the highlights discussed were high-precision diameter measurements of planets and satellites, using double-image and disk micrometers; intensive observations of Martian surface detail; and extensive laboratory studies of the spectra of molecules expected to occur in planetary atmospheres. Many of these investigations are still unpublished, including some important visual observations of planetary surfaces made by Dr. Kuiper.

At its 1954 opposition, Mars was observed by him with the 82-inch McDonald telescope, using a 900x binocular eyepiece attachment. The color of the dark markings, traditionally described as green, was found to depend on the seeing. "With perfect seeing all maria appeared merely darker than the 'deserts,'" Dr. Kuiper reported, "but essentially of the *same* color, throughout the entire period."

On a nearly perfect night in 1954, the Yerkes astronomer examined the rings of Saturn and the planet Neptune with the 200-inch Mount Palomar telescope, using a power of 1,170. He found that, of the many divisions reported in the rings, only Cassini's is a real gap. The others are either zones of slightly lower brightness, or are nonexistent. Neptune showed a beautifully defined disk with no spots; the brightness of the edge was only 0.6 that of the center of the disk.

A project with which this commission has been concerned is reform of the nomenclature of Martian surface features, which has become unwieldy. One proposal discussed was that of the late G. Fournier, who recommended that names be retained for only 155 reasonably permanent features, and that symbols be used for transitory markings. On his plan, the symbol would indicate the general location of the marking and describe its type.

There was agreement among the commission members that the time has come to prepare a new photographic lunar map, based on the best available photographs with large telescopes. It was suggested that this map be on a scale of about 10 feet for the lunar diameter, and that each area be shown under several conditions of illumination. A rectangular grid on the charts would provide an easy and unambiguous means for identifying minute details.

The naming of lunar features is a responsibility of the IAU, and specifically of Commission 16. Former confusion in this field was ended in 1935 by publication by the IAU of *Named Lunar Formations*, by M. A. Blagg and K. Mueller. This work, consisting of a catalogue and atlas, is the internationally recognized authority for the names of craters and other formations.

To avoid return to the previous ambiguities, the commission has not approved repeated suggestions for adding names of contemporary scientists to the already long list of accepted crater designations. The following resolution was adopted by the general assembly at Dublin:

"This commission [16] recommends to the Union that at the present time—and particularly pending the completion of the photographic map of the moon—no official recognition shall be given to additional lunar nomenclature."

Comets

REVIVAL of interest in cometary problems of all kinds was conspicuous at Dublin. Physical studies of comets come within the scope of Commission 15, but matters concerning their orbits fall more naturally to Commission 20, whose primary subject is minor planets.

The majority of the discoveries of comets are still made visually, and some details were reported of the very productive searches carried out at the Skalnate Pleso Observatory in Czechoslovakia. The observers there find one comet for each 200 hours of search, on the average, when 4-inch f/4.2 binoculars are used.

The structure of comets received much attention. One long-debated problem concerning cometary dimensions now seems settled, by M. Beyer in Germany from his own observations of 46 comets, and N. T. Bobrovnikoff, Ohio State University, from collected data on more than 300 apparitions. Both find that a comet's head gradually expands as it approaches

Dr. G. P. Kuiper, of Yerkes and McDonald Observatories, here presides at the meeting of the planetary and satellite commission.

At the left, Dr. N. T. Bobrovnikoff, Ohio State University, addresses one of the sessions of Commission 15. At the right, Commission 25, Stellar Photometry, meets under the chairmanship of Dr. W. M. H. Greaves, of Edinburgh Observatory. Acting as secretary is H. E. Butler, also of Edinburgh.

the sun to within 1½ astronomical units, and thereafter shrinks. The point was brought out, however, that the visual or photographic diameter of a comet is such a vague concept that it would be desirable to have photoelectric size determinations, in monochromatic light.

Another problem clarified is the cause of the long, very straight tails that some comets have, consisting of ionized gases such as carbon monoxide. As these tails point directly away from the sun, some powerful repulsive force is operating; but this cannot be the pressure exerted by sunlight, which readily repels dust particles but is ineffective against gas molecules. Now L. Biermann, of Goettingen, has shown in detail how the high-speed ions known to be ejected from the sun can repel cometary matter to form this variety of tail.

Commission 20 approved the proposal of the British Astronomical Association to publish a comprehensive general catalogue of comet orbits, replacing Galle's *Kometenbahnen* with complete, modern data. To defray the cost of this publication, it was recommended that $1,400 be granted to the BAA.

FACING PICTURE: Halley's comet on its last return, as photographed with the Mount Wilson 60-inch reflector on May 8, 1910. On this date, 19 days after passing perihelion, the comet was 48 million miles from the earth. Visible in the morning sky, the comet's head was then as bright as a 2nd-magnitude star, and its tail was about 19 degrees long. The tiny nucleus is lost in the overexposed image of the head in this photograph. Halley's comet will next return to the sun's vicinity in February, 1986.

The Unit of Time

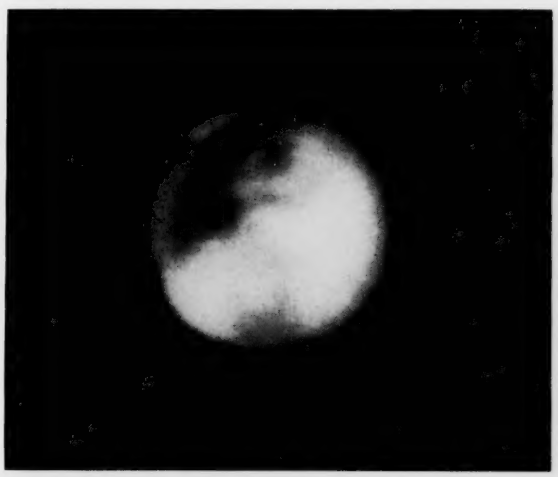
HITHERTO the basic unit of time has been the mean solar second, the 1/86,400 part of a mean solar day. This mean solar or Universal time is based on the rotation of the earth, and it is obtained in practice from observations of the stars. In recent years, however, astronomers have become increasingly aware that the rate of the earth's rotation is not uniform. There are seasonal variations in the length of the day, as well as small, slow erratic fluctuations, superimposed on a very gradual progressive lengthening.

For precise applications in many fields of science and technology, an invariable unit of time is needed, and accordingly it had been proposed that this should be based upon the earth's orbital motion rather than its rotation.

In September, 1952, at Rome, the International Astronomical Union had adopted a resolution recommending that the sidereal year for 1900.0 be employed as the unit of time where the variability of the mean solar second made the latter unsuitable. (The sidereal year is the period of the earth's orbital revolution—it can be measured by the interval required for the sun to travel around the ecliptic from a particular star back to the same star again.)

It was decided later, however, that some practical advantages would be gained by basing the unit on the tropical year for 1900.0 instead of the sidereal year. (The tropical year is the interval between two successive passages of the sun past the vernal equinox—it is the year of the seasons.) The tropical year is roughly 20 minutes shorter than the sidereal year.

The International Committee on Weights and Measures, meeting in Paris in September, 1954, proposed to the Tenth Conference on Weights and Meas-



Observations of Mars in 1954 with television techniques were discussed at Dublin. This is a composite of four photographs of a television picture obtained in connection with the 24-inch refractor at Lowell Observatory, as described by W. M. Sinton on page 363 of the July issue. The dark marking forming the pupil of the "eye of Mars," near the top (south) of the planet, is Solis Lacus. Lowell Observatory photograph.

ures, which met there in the following month, that the second be defined as a specific fraction of the tropical year for 1900.0. The Tenth Conference empowered the International Committee to adopt a new unit of time after the International Astronomical Union had acted formally on the definition.

Therefore, at Dublin, upon a proposal by Commission 31, the following resolution was adopted:

"The General Assembly of the IAU approves the definition of the second proposed by the Comité International des Poids et Mesures, as follows:

The second is the fraction 1/31,556,925.975* of the length of the tropical year for 1900.0.

*The more precise value required for exact agreement with Newcomb's *Tables of the Sun* is 1/31,556,925.97474."

The second of Ephemeris time is the unit defined by the above. Ephemeris time thus flows at a uniform rate. Basically the independent variable of the equations of motion of celestial bodies, Ephemeris time is the time argument of astronomical ephemerides. Universal time continues in use for ordinary purposes and will be the time indicated by clocks.

The difference, Ephemeris time minus Universal time, can be determined for some particular date by the comparison of ephemeris positions of suitable celestial bodies with observations recorded in Universal time. In actual practice, obser-

In the garden of University College, Dublin, delegates to the International Astronomical Union

vations of the moon are the best suited.

Hitherto, occultations of stars by the moon and meridian observations of the moon have been used. It is expected, however, that in the near future observations with the dual-rate moon cameras, developed by Dr. W. Markowitz at the U. S. Naval Observatory, will allow the difference between Ephemeris time and Universal time to be determined more accurately. This recently invented instrument is described on page 5 of the November, 1953, *Sky and Telescope*.

In addition to the resolution itself, the IAU adopted a technical explanation, whose full text appears in *Nature*, Vol. 176, p. 669, 1955.

ASTEROID STRATTONIA

The minor planet 1560, discovered by the late E. Delporte at Uccle, Belgium, on December 3, 1942, has been named Strattonia by its discoverer, for F. J. M. Stratton, retired professor of astrophysics at Cambridge University.

The name of the asteroid was announced at the conversazione of the Royal Astronomical Society on August 23, 1955, when Professor Stratton was presented with advance proofs of the commemorative book, *Vistas in Astronomy*, which had been initiated in honor of his 70th birthday. The two-volume survey of modern astronomy has been edited by Arthur Beer, of Cambridge University Observatory, and contains 192 contributions from 215 authors in 26 countries. It will be published by Pergamon Press.

ssembly gathered with their families and guests for this picture, which was taken August 27, 1955.

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BOOKS AND THE SKY

OPTICAL WORKSHOP PRINCIPLES

Charles Deve. Hilger and Watts, Ltd., 98 St. Pancras Way, Camden Road, London N. W. 1, 2nd English edition, 1954. 436 pages. 42s.

THIS translation of Col. Dévé's fine volume, *Le Travail des Verres d'Optique de Precision*, is indeed a welcome addition to the far too few publications that have dealt with the practical methods of optical manufacture. It is a considerable enlargement of the 1942 English edition.

The author was the founder and first director-general of the Institute of Theoretical and Applied Optics, Paris. In his long military career in optical ordnance, he developed not only a number of optical instruments but, more significantly perhaps, many new methods for working optical surfaces, which to a considerable extent have proven revolutionary in the precision optical industry in France and elsewhere.

At the beginning of the book, the author has placed a warning: "It is no manual for beginners. It is a resume of the technological instruction which is given partly to apprentices in the technical school for optical work and partly to foremen and optical workers who come to improve themselves at the Institute of Theoretical and Applied Optics."

The first of the book's two parts is an elementary section of about 145 pages, of particular interest to precision opticians. Chapter 1 describes various types of optical glass, their faults, and proper choice of materials. Chapter 2 is a very complete discussion of abrasives, cements, and polishing tools. The next chapter, on surfacing, is truly outstanding. Here the author states several laws of surfacing which any optical worker will find practical and helpful. The rather complicated geometrical proofs of these laws are treated mathematically later in the book. The fourth chapter, on spectacle lenses, gives the apprentice optical worker detailed descriptions of tools and proper methods of roughing, truing, smoothing, polishing, and so on.

Part II, considerably more technical, is intended for plant managers, shop foremen, and master opticians. The author describes the mechanical theory of the working of optical surfaces, explaining fully the various standard methods of grinding and polishing which cause unequal wear on tool and work. Several very novel devices developed by the author to overcome difficulties of accurate grinding are described.

Chapter 6, on optical tests in the workshop, covers extensively the use of test plates for flats, plane-parallels, spherical and aspherical surfaces. Several pages are devoted to the testing of parabolic telescope mirrors with test plates, one of the few explicit references to astronomical optical work in the book. Next comes a rather full discussion of working polarizing materials, such as crystal quartz and Iceland spar. This chapter is probably the most complete up-to-date information available for the practical working of some crystal materials.

The excellent description of centering, edging, and cementing of lenses will be found of great assistance. In the discussions of reticles and the engraving of glass, there are many hints and practical working methods not found easily elsewhere. There is a chapter on silvering, copperplating of silver, and aluminizing.

The most important appendixes deal with surfacing aspherical lenses, most certainly the best information yet published, and with local retouching of optical surfaces, for which both the theory and its practical application are considered fully.

The English translation is by Thomas L. Tippell. Hilger and Watts is to be congratulated on the translation and publication of this volume, which is a worthy companion to F. Twyman's *Prism and Lens Making*. The secrecy that has often shrouded precision optical techniques has been removed in these and other Hilger and Watts publications, and

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Hevelius wrote convincingly of the ease and rapidity with which he could prepare the 150-foot telescope for observation,[15] but the opposite was more probably the truth. The tall mast was the only fixture, for the proximity of the site to the Baltic Sea precluded the permanent elevation of the tube. A band of assistants was required to work the different ropes that either raised or lowered the tube.' Then the object had to be located and "followed" with high magnifications. This is difficult enough with a small telescope, let alone with a long, flimsy tube moved by several pairs of rough hands. Only the finest nights were suitable for observing, for the slightest breeze would cause the framework to quiver like a reed . . . .

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that company has been more than a little responsible for the much freer exchange of technical information among optical firms in recent years.

The book will have wide appeal to the professional optical worker and the advanced amateur.

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BINOCULARS, TELESCOPES AND TELESCOPIC SIGHTS

Truman Henson. Greenberg Publishers, New York, 1955. 515 pages. $9.50.

ONE FIELD in which the creative talents of home workshop craftsmen has not flourished is that of optical instruments (except reflecting telescopes). Yet, with diversified stocks of optical elements on hand at various surplus dealers, the home construction of telescopes, rifle scopes, binoculars, and similar instruments is not only quite feasible but should be definitely appealing. One reason for this small activity is a lack of understanding of the fundamental principles of optical instruments and the details of their mechanical construction.

Mr. Henson's book has the avowed purpose of correcting this lack of understanding and of opening the field of optical instruments to the interested tinkerer, whether he wishes to create his own instrument or merely to apply preventive and corrective maintenance to a purchased item.

This purpose the book has achieved in large measure. Although there are various points with which a professional can take issue, the uninitiated will find it instructive and interesting. The author sets forth in considerable detail the mechanical construction and arrangement of binoculars, observation telescopes, and rifle scopes, and presents several original designs and instructions for fabrication and assembly, using available optical components. There is much useful discussion of the characteristics of these instruments, and the factors that should be taken into account in their selection and purchase—discussion that a prospective purchaser will find very valuable. Appendixes give the characteristics of a long list of commercially available instruments from which a selection can be made.

The book is extremely well illustrated, and contains numerous "exploded" views of instruments—some from Army technical manuals. For the individual who wants practical information on the mechanical construction of these instruments, and only enough facts about optical principles to enable him to work effectively in assembly, disassembly, and adjustment, the book is highly recommended.

From the standpoint of optical principles, however, the book is not suitable for one who already has some understanding of how lenses work. In at-

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Space exploration is on . . . the Moon will be first, then the Planets! Approved by the world's largest Planetarium and Science Foundation as a novel, educational and playable toy, the Moon Ball is 7" in diameter and is a relief reproduction of the only side of the moon seen by man. Complete with a story about the moon and a map identifying the prominent markings, "Moon Balls" will soon be in stores across the nation. Order yours by sending $1.50 to "Moon Balls" at the address below. Distributors, Wholesalers, Retailers—write

MANNING'S MOONBALL CO., INC.
4321 Perrier Street, New Orleans

tempting to simplify the optical presentation by leaving out all the mathematics, the author has omitted a great deal of important information, and there are several cases of careless or incorrect use of terminology which will, in the opinion of this reviewer, serve to confuse the reader who comes into contact with other books on the subject.

In particular, the author's definition of the angle of incidence, and therefore of the critical angle, is not in accordance with accepted practice; his definition of ray tracing is incorrect, as is his use of the term collimation. There is no discussion of the vitally important subject of apertures and pupils; and the very useful applications of field lenses are not brought out.

The word *reversion*, which should be eliminated from optical vocabularies, is used in this book with an entirely new and useless meaning! The problem of terminology in optics is a difficult one, and even accepted definitions are often confusing; authors in the field should not add to the confusion.

The foregoing criticisms are included here to warn those to whom such things make a difference—those who have already been, or who hope to be, taught by other teachers.

EARLE B. BROWN
Farrand Optical Co.

NEW BOOKS RECEIVED

EXPLORING THE MOON, *Roy A. Gallant*, 1955, *Garden City*, 63 pages, $2.00.

A book for young people, in large format and with brightly colored drawings, gives some idea of how the moon looks, what it is, and what we might experience if traveling on its surface.

THE FORESEEABLE FUTURE, *Sir George Thomson*, 1955, *Cambridge University Press*, 166 pages, $2.50.

How technology may affect the futures of such fields as energy, transportation, meteorology, biology, and others, is told by a Nobel prizewinner in physics.

THE HISTORY OF THE TELESCOPE, *Henry C. King*, 1955, *Sky Publishing*, 456 pages, $12.50.

Tracing the development of astronomical instruments, and particularly telescopes, through the centuries, the author at the same time tells the story of the growth of observational astronomy.

THE GOLDEN BOOK OF ASTRONOMY, *Rose Wyler* and *Gerald Ames*, 1955, *Simon and Schuster*, 97 pages, $4.95.

Lavishly illustrated in color, this large-sized book for children gives a survey of astronomy, with particular attention to the members of the solar system. The last few chapters describe a trip to the moon.

THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC FOR THE YEAR 1957, *Nautical Almanac Office*, U. S. Naval Observatory, 1955, *U. S. Government Printing Office*, Washington 25, D. C., 586 pages, $4.50.

As for preceding years, the 1957 volume of this valuable reference work gives accurate ephemerides for the sun, moon, planets, and first four asteroids; predictions of eclipses and occultations; ephemerides for observers of satellites; and much other material for the computer and serious observer. The principal change is that the apparent places of standard stars are no longer included.

No. 732 A 6" celestial globe shows all major stars and constellations, the equator, and the ecliptic. Mythological background emphasized in five brilliant colors. Includes meridian circle and base, with 155-page book, *Stars*. **$4.00**

No. 731 This attractive 9" globe has a dark blue background with yellow stars to the 6th magnitude. Ecliptic and equator shown. Constellations outlined. Movable meridian and horizon ring. Attractive plastic cradle. **$14.50**

No. 792 Philips' Planisphere is a perpetual star map. Consists of two movable disks: bottom is star map, top is a time mask. May be set for any date and time of night to show the stars that are visible then. **$3.50**

Science Associates
194 Nassau St., Box 216, Princeton, N. J.

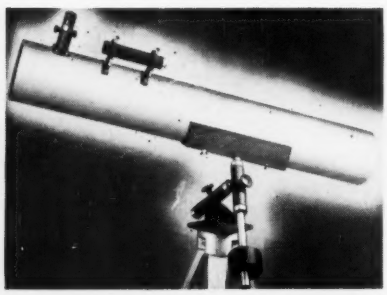
BUILD YOUR OWN 3" REFLECTING TELESCOPE with this COMPLETE, 87-PIECE Do-It-Yourself KIT!

Complete parts—no machining—easily assembled; a nine-year-old can do it! All nuts and bolts supplied. Nothing extra to buy. Kit includes 3" spherical mirror 30" F.L., aluminized and overcoated. Guaranteed to resolve detail right up to theoretical limit. Tripod 40" high with cast-iron tripod head, all holes drilled and tapped (all machining finished). Other parts made from ⅛" thick steel all ready to assemble. Smoothly functioning equatorial mounting. Locks on both polar and declination axes. Polar axis at 40°; latitude adjustment made with tripod legs. Natural grain finished hardwood tripod legs. Heavy wall black kraft telescope tube with special black glare-reducing liner. Eyepiece mount has slide focus adjustment. Mirror attaches on new type mounting with pressure-sensitive adhesive tape eliminating distortions. Mirror is ventilated. 60X eyepiece and a 100X Barlow lens included. 90X and 120X eyepieces available at extra cost. Crosshair finder parts included with mountings. Parts zinc plated to prevent rust. A real kit in every respect. Can also be used terrestrially. Nothing extra to buy. Directions included! Money back guarantee.

Stock #85,025-Y ..... $29.50 f.o.b.

EXCEPTIONAL BUY IN A Complete, Assembled 6" REFLECTING TELESCOPE

40X, 60X, 120X, 150X, 300X



Complete with heavy duty equatorial mounting and tripod. Tripod has cast aluminum head and rugged wooden legs for stability. (Folds for storage.) Equatorial mount has 1" diameter shafts with Boston bronze bearings. 5-lb. counterweight for perfect balance. Locks on both declination and polar axes. Polar axis set at 40°; latitude adjustment made with tripod legs. Black crinkle finish on mount. Telescope tube made of aluminum; white enamel finish on outside. Rack-and-pinion focusing eyepiece mount. 7X achromatic finder with crossline reticle. 6" Pyrex parabolic mirror—48" F.L. (f/8)—aluminized and overcoated—guaranteed to give theoretical limit of resolution. Mirror mount machined cast aluminum. Kellner eyepiece gives you 40X and a Goto combination eyepiece gives 60X and 120X. A Barlow lens is included to give 150X and 300X. Shipping weight 75 lbs.

Stock #85,024-Y ..... $245.00 f.o.b.

SPECIAL NOTICE

We Are Liquidating a Huge, Newly Acquired Stock of U. S. Gov't. Telescopes . . .

Your Chance to Pick Up an Excellent Bargain

READ THE DETAILS CAREFULLY — THEN BUY!

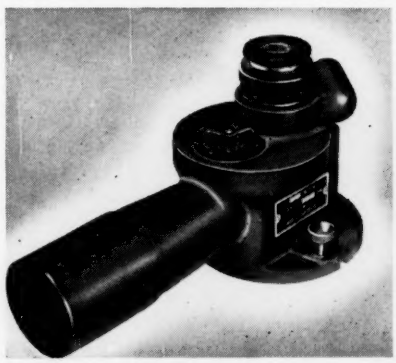
M-17 8-POWER ELBOW TELESCOPE

$200 VALUE FOR ONLY $12.50 POSTPAID

BIG 2" OBJECTIVE—KELLNER EYEPIECE—AMICI ERECTING PRISM

4 BUILT-IN FILTERS—RETICLE ILLUMINATION

This is Edmund's biggest bargain offer in an entire decade. Weight of this instrument is 5 pounds. Field is 6°, exit pupil is 0.243 inch. Excellent for finder on an astronomical telescope. Ideal for use as a mounted telescope for terrestrial observation. Also can be used for telephoto photography. Objective lens can be removed and a tube added with a longer focal length objective to convert to a high-power astronomical telescope. The focusing 28-mm. F.L. eyepiece alone is worth more than $12.50. These telescopes were designed for spotting airplanes in the sky and have excellent resolving power and definition. The image is sparkling clear and bright — will delight you. Adjustable focus from 15 feet to infinity. These instruments are in good condition — practically new. You can buy this exceptional bargain with absolute confidence. In accordance with the policy prevailing on all Edmund merchandise, we guarantee complete satisfaction or your money back.



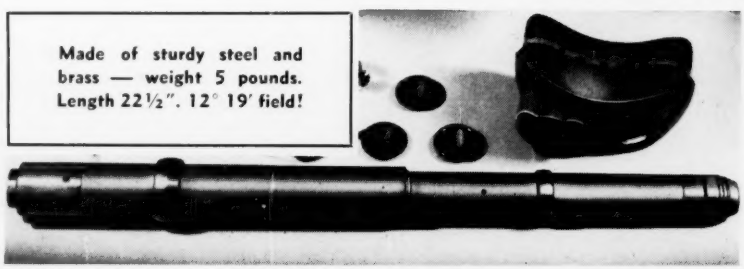
Stock #70,065-Y ..... $12.50 ppd.

M-70 3-POWER TELESCOPE

A $75 VALUE FOR ONLY $7.50

Bear In Mind!
Edmund Optical Items Make Dandy XMAS GIFTS!

Made of sturdy steel and brass — weight 5 pounds. Length 22½". 12° 19' field!



Another fine quality instrument throughout — produced by America's leading optical manufacturers. Telescope consists of a Kellner eyepiece, reticle, 2 achromatic erector lenses, 1 achromatic objective lens (25-mm. diam.), and a protective window. All optics are low-reflection coated. Also included: a rubber eyeguard, and amber, red, and neutral filters for snapping on to eyepiece. All these telescopes equipped with small window through which reticle can be illuminated with small flashlight.

By removing 3 screws, you can separate scope into 2 pieces, one of which makes an excellent 6-power finder for an astronomical telescope on which reticle can be illuminated for night use. To give you some idea of the intrinsic value you are getting here — as surplus, the lenses alone would cost double the price we are asking for the entire instrument. Bear in mind, too, that the eyepiece by itself can be used for an astronomical telescope.

Stock #80,055-Y Completely boxed with protective absorbent, exactly as received from Army (new or near new) ..... $7.50 ppd.

Stock #80,051-Y Telescope only (used—good condition) ..... $4.00 ppd.

THE MOUNTING RINGS FROM OUR STANDARD 7-POWER FINDER CAN BE USED ON THE ABOVE M-70 TELESCOPE

Stock #50,075-Y Ring mounts per pair ..... $4.95 ppd.

EDMUND SCIENTIFIC CORP.

ACHROMATIC ASTRONOMICAL TELESCOPE OBJECTIVES

Real Quality at Bargain Prices

Make Wonderful Refractors

For three years we checked U.S., German, and Japanese manufacturers looking for one who could produce really good telescope objectives at a low price. A few times we ordered samples only to be disappointed in quality or final price. Finally, we found a Japanese optical engineer who designed some excellent astronomical objectives. We place orders with him. He then has these made, checking each one for quality. Thus, we are able to offer objectives we believe to be as good as those selling for two or three times our price.

Our 3" and 4" diameter objectives are air-spaced achromats, as air-spacing gives the lens designer four surfaces with which to correct aberrations, instead of only three as in a cemented achromat. The results are a beautiful, color-free image, sharp, clear, with very flat field, no bad zones, and full correction against coma.

Stock No.	Diam.	F.L.	Price	Comments
30,166-Y	3"	45"	$28.00	Not coated
30,190-Y	3"	45"	32.00	Coated
50,106-Y	4"	60"	60.00	Not coated
50,107-Y	4"	60"	69.00	Coated on four surfaces

Metal cells are available for the objectives above.

Stock #70,063-Y.....$11.95 for 4" objective

Stock #70,064-Y.....$10.95 for 3" objective

LOW COST, LONG F.L. ACHROMAT

Stock #30,187-Y 50" F.L., 2" diam., coated . . . $12.50 ppd.

Rack & Pinion Eyepiece Mounts

For Reflectors

For Refractors

Now you can improve performance in a most important part of your telescope — the eyepiece holder. Smooth, trouble-free focusing will help you to get professional performance. Look at all these fine features: Real rack-and-pinion focusing with variable tension adjustment; tube accommodates standard 1¼" eyepieces and accessory equipment; lightweight aluminum body casting; focusing tube and rack of chrome-plated brass; body finished in black wrinkle paint. No. 50,077-Y is for reflecting telescopes, has focus travel of over 2", and is made to fit any diameter or type tubing by attaching through small holes in the base. Nos. 50,103-Y and 50,108-Y are for refractors and have focus travel of over 4". Will fit our 2⅞" I.D. and our 3⅞" I.D. aluminum tubes respectively.

Stock #50,077-Y (less diagonal holder) $9.95 ppd.
Stock #60,035-Y (diagonal holder only) 1.00 ppd.
Stock #50,103-Y (for 2⅞" I.D. tubing) 12.95 ppd.
Stock #50,108-Y (for 3⅞" I.D. tubing) 13.95 ppd.

HUYGENS EYEPIECES

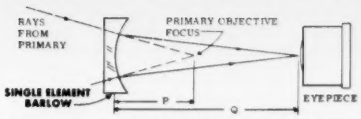
Here are some really terrific values in eyepieces! The three eyepieces listed below are manufactured by one of the world's best producers of optical components. We have searched the world's markets, including Germany and France, to find a real quality eyepiece. The image clarity, the workmanship evidenced in the metal parts, will prove the skill and experience of Goto Optical Company, Tokyo. Guaranteed terrific buys!

HUYGENS TYPE — STANDARD 1¼" DIAM.
6 mm. (¼") Focal Length
Stock #30,063-Y ..... $8.50 ppd.
12.5 mm. (½") Focal Length
Stock #30,064-Y ..... $8.00 ppd.

COMBINATION EYEPIECE—10 mm. and 20 mm.
Stock #30,065-Y ..... $9.00 ppd.

DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER

with a BARLOW LENS



WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power.

The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q!

ACHROMAT OR SIMPLE BARLOW? An achromatic Barlow lens will give best results, but our low-priced single-element lens will give you 90% of the performance of the achromat. In fact, on and around the axis, the image will be just as good, with slight additional color at the edges of the field. SINGLE ELEMENT BARLOW — FOCAL LENGTH 1-5/16". Our short focal length means that you do not have an unwieldy long tube at the eyepiece.

Stock #30,175-Y. Unmounted, O.D. 1-3/16". Coated. Fits in tubing listed below. $3.00 ppd.

Stock #30,140-Y. Mounted Achromatic Barlow Lens ..... $15.00 ppd.

30-day Money Back Guarantee as with all our Merchandise!

BRASS TUBING

2 pieces, 3" long, slide fitting. Blackened brass. I.D. 1-3/16". O.D. 1-5/16". To fit single-element Barlow above.

Stock #40,165-Y ..... $1.25 ppd.

7X — FINDER TELESCOPE — ACHROMATIC

Stock #50,080-Y Finder alone, less ring mounts $9.95

Stock #50,075-Y Ring mounts per pr., $4.95

ASTRONOMICAL TELESCOPE TUBING

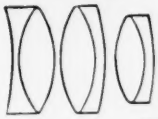
Stock No.	I.D.	O.D.	Lgth.	Description	Price
80,038-Y	47⁄8"	5¼"	46"	Spiral-wound paper	$2.50
85,008-Y	7"	7½"	60"	Spiral-wound paper	4.00
85,011-Y	2¾"	3"	48"	Aluminum	6.00
85,012-Y	3¾"	4"	60"	Aluminum	8.75
85,013-Y	4⅞"	5"	48"	Aluminum	9.00
85,014-Y	6⅞"	7"	60"	Aluminum	15.00

All tubing is shipped f.o.b. Barrington, N. J.

MOUNTED ERFLE EYEPIECE

68° FIELD OF VIEW

Consists of 3 coated achromats in metal mount with spiral focusing. F.L. 1¼". Diam. 54 mm., length 54 mm.



War surplus. Govt. cost about $84.00. This is the type war-surplus bargain that will be talked about in years to come. Buy while you can.

Stock #5160-Y, $12.50 ppd.

ADAPTER

Provides 1¼" diameter mount to fit standard eyepiece holders.

Stock #30,171-Y $3.95 ppd.

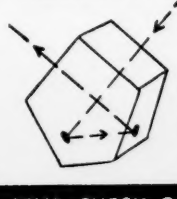
1¼" diam.

WAR SURPLUS TELESCOPE EYEPIECE

Mounted Kellner Eyepiece, Type 3. 2 achromats, F.L. 28 mm., eye relief 22 mm. An extension added, O.D. 1¼", standard for all types of telescopes. Govt. cost $26.50.

Stock #5223-Y, $5.95 ppd.

MAKE A SUN DIAGONAL



Because it is unsilvered, this PENTA PRISM transmits only .0016 of the light it receives, making it an excellent sun viewing diagonal, if used with proper precautions. Entrance and exit faces 1" and 1" approximately.

Stock #3262-Y $3.75 ppd.

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our Palomar, Jr., polished and aluminized, lenses for eyepieces and diagonal. No metal parts.

Stock #50,074-Y ..... $16.25 ppd.

LATEST MODEL SPITZ Jr. PLANETARIUM

Designed by Armand Spitz. Projects nearly 400 stars, more than 70 constellations in their correct relationships. Use it in any darkened room of the house, project it on walls and ceiling. No batteries, works on ordinary household current. Two simple adjustments that show you the sky as it appears from any point in the Northern Hemisphere . . . for any time of night . . . for any month of the year! Rheostat brightness control. A 32-page book included free of extra cost. Contains valuable information about the stars, provides easy identification of the constellations. Also FREE — illuminated pointer.

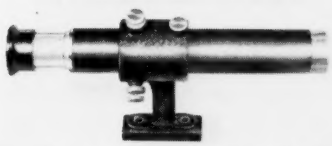
About 14" high on a 7" x 7" base.

Stock #70,040-Y ..... $14.95 ppd.

Stock #70,059-Y Sky Zoo Projector $3.98 ppd.

Stock #70,060-Y Southern Hemisphere Projector ..... $3.98 ppd.

5X FINDER TELESCOPE



Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube — an important advantage. Has 3 centering screws for aligning with main telescope. 20-mm. diam. objective. Weighs less than ½ pound.

Stock #50,121-Y ..... $8.00 ppd.

MISCELLANEOUS ITEMS

STAR SPECTROSCOPE — Imported! Doubles the usefulness of your Telescope. 2¾" long.

Stock #50,023-Y ..... $32.75 ppd.

60° SPECTROMETER PRISM — Polished surfaces 18 mm. x 30 mm. — flat to ½ wave length.

Stock #30,143-Y ..... $8.25 ppd.

BE SURE TO GET FREE CATALOG "Y"

Fantastic variety — never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Write for Free Catalog "Y."

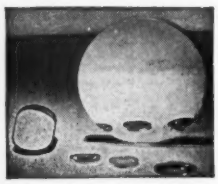
ORDER BY STOCK NUMBER . . . SEND CHECK OR MONEY ORDER . . . SATISFACTION GUARANTEED!

BARRINGTON • NEW JERSEY

FINE TELESCOPE EYEPIECE

Made by a Famous Optical House

Well corrected — ¾" e.f.l. (15x). Outside diam., 1¾". Eye lens, ¼" diam., field lens, ⅜" diam. A finely corrected Huygens with high eye relief. Priced very low by popular demand. Limited stock. **ONLY $8.00** plus 25c p.p.



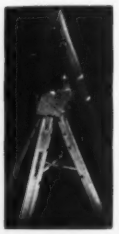
5" Telescope Mirror 67" F.L., Ground, Polished, Aluminized, only **$13.00**

Overstocked Selling Out Special

Our regular precision-made 5" Aluminized Telescope Mirrors from 1" blank, crown glass. Regular $17.00, while they last **ONLY $13.00 plus $1.00 p.p.**

4-ARM DIAGONAL FOR REFLECTING TELESCOPES

Prism in metal mounting. Spider mount fits 5-6-7 or 8" tube. Light flint glass prism, fluoride coated, 1⅝" x 1⅝" face. Metal connecting arms present little obstruction to path of light. Prism centering easily adjusted to every difference of tube diameter or optical placement. Complete, **$10.00** plus postage. Specify your tube size.



3" ROSS STELLARSCOPE

40 and 80 Power

Improved Model—$16.50

Same principle as Mt. Palomar 200-inch Telescope. Exquisite definition. Unassembled.

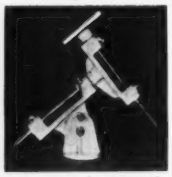
Learn optical principles and astronomy and save money, too, by assembling your own 3" ROSS STELLARSCOPE. For beginners and amateurs. Kit is complete (no lens polishing necessary) for just **$16.50** plus postage for 9 lbs. Add a Ross Quadripod (as illustrated) for only **$18.00** more, unassembled.

PRISMS—Giant Size, Brilliant-Crystal

White Optical Crown Glass

Dozens of wonderful things to do and make. Sunlight rainbows, periscopes, secret pictures with cameras, look around corners, over fences, upside down. Hundred more uses including astronomy. 6½" x 2". 45-90 degrees. Aluminized back, mounted. Limited stock. U. S. surplus cost $22.00. BUY TWO. **NOW ONLY $2.50 EACH plus p.p. 2 lbs.**

EQUATORIAL MOUNTING



Aluminum and steel Finished in grey lacquer. Will handle any telescope up to 6" diameter. All bearings guaranteed against play. Every motion of the instrument feels as smooth as silk.

The polar axis is adjustable. The telescope can be moved north-south in declination and east-west in time or right ascension to any part of the sky.

To 6" Mirror, Complete $35.00 plus p.p.
Up to 10" Mirror, Complete $60.00 plus p.p.

Remit with order. Include postage. No C.O.D.

HARRY ROSS

Telescopes - Microscopes

Comprehensive Catalog — $1.00; Deductible from First $10.00 Purchase

70 West Broadway, New York 7, N. Y.

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

A 6-inch Newtonian with Hydraulic Drive

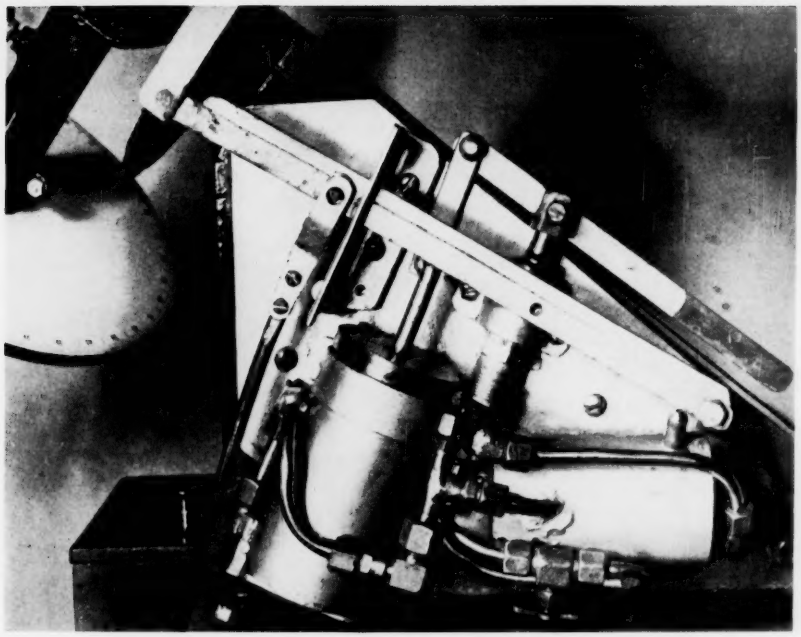
MY QUALIFICATIONS for building a 6-inch reflector were patience, perseverance, a certain amount of inventive ability, and the determination never to allow a part to go into the scope that did not work perfectly. I learned early that care and precision were necessary to produce an instrument that would do the things I wanted it to do. Nearly twice as much money ($400) was spent building it than would have been needed if I had known how to do everything correctly in the beginning.

The final result, however, is satisfactory. Few other instruments can compete with mine in locating any object in the sky within five to eight seconds. There is no hunting and guessing—set the circles and there it is.

The first trouble was with the mirror, which was overcorrected by 200 per cent when I bought it. It would not even resolve the Trapezium stars in the Orion nebula. I had it refigured by Thomas Cave, Jr., and substituted an elliptical flat for the original prism diagonal. Since then the performance of the mirror has been perfect.

To solve the problem of saddle adjustment, I actually have two saddles. The first is smaller than the one carrying the tube, and has a hole bored in its center to allow the declination shaft to protrude about ⅛". The declination shaft should

B. A. Stevens' 6-inch reflector was built with as many refinements as possible, including a permanent mounting place on a concrete block. The weight that operates the drive is suspended from a rod alongside the tripod leg in the lower center of this picture.



This enlarged picture of the hydraulic drive shows the working parts. The cutoff valve at the lower right is to prevent seepage of fluid back through the check valves.

be rounded on the end. The first saddle is welded to it at exactly right angles. The second saddle is placed on the shaft in the first saddle and secured with four ¼" screw bolts. I placed two pieces of heavy cloth belting at each end of the second saddle for the tube to rest upon. By adjustment of the four bolts, I can line up the tube so the hour circle reads exactly 0 and 12 hours, and the declination readings agree, when the same star is sighted on the meridian with the telescope on either side of the pier.

The declination and polar axis shafts were machined very carefully out of solid steel and fitted into bronze bushings. For the mounting head support I used a U-joint from a truck, which permitted centering the declination shaft directly over the polar axis and exactly at right angles to it. A small error in this construction will result in an inaccurate mounting, and it will be impossible to make the circles work as they should.

The hydraulic drive was perfected after many headaches and seemingly unsolvable problems; I am quite sure there is no other drive like it anywhere. It turns the telescope accurately for three hours at a time, and takes less than a minute to reset for another three hours. It is rugged and strong, noiseless, steady as a rock, and smooth as silk. The drive consists of a pump from a small hydraulic jack, with check valves, a small supply tank, a cylinder and piston, and a return for the fluid to the supply tank through a filter and a needle valve. The piston is pulled down by a 25-pound weight. The arm to which the weight is attached rests on the piston rod and is attached to the slip-ring clutch by tracks taken from a camera bed.

As the weight pulls the lever down, the cogged track turns the center pressure

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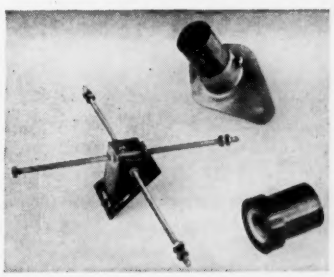

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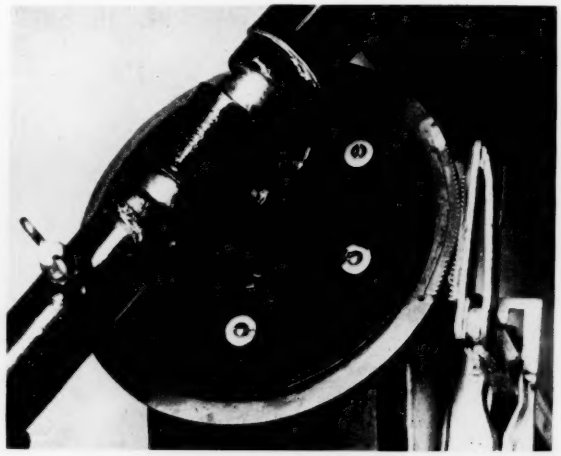
disk of the clutch, which turns the telescope. The rate of turning is governed by the needle valve, which controls the speed of the liquid's return to the supply tank. No ordinary hydraulic fluid will work satisfactorily—it changes its viscosity with the temperature and requires continual adjustment of the needle valve. I finally procured a silicone oil from General Motors; this oil changes very little during normal weather and an adjustment is seldom necessary.

The clutch consists of a sandwich of disks cut from $\frac{1}{8}$" cold steel. Between two 6" disks is one $4\frac{3}{4}$" in diameter, around which fits a larger slip-ring disk $6\frac{3}{4}$" in outside diameter. The first 6" disk is welded to the U-joint on the polar axis, then the odd-sized disks are slipped on and held in position by the second 6" disk. The $6\frac{3}{4}$" slip ring protrudes from between the 6" disks, and has a $3\frac{1}{2}$" section of the camera track inserted to engage the cogs on the pull-down arm of the drive. It is this disk that slips when the telescope is moved rapidly by hand, but the moment one ceases to turn the tube the drive takes hold instantly.



This is the slip-ring clutch, showing three of the six machine screws for controlling pressure on the center disk. The springs are under the washers of the screws. The camera tracks for the power takeoff can be seen at the right. The black band over the center of the U-joint is an adjustable drag for the declination shaft.

The disks were all ground flat, but the $4\frac{3}{4}$" center one is about 0.005" thinner than the two outside disks. This disk and the outer one have six holes bored at points along a circle, and the bottom 6" disk has smaller holes that are threaded to take small machine screws. When the screws were inserted, springs and washers were mounted under their heads; they pass through the upper 6" disk, the center ring, and are tightened to the bottom 6" disk. The springs provide just the right tension to produce pressure between the 6" disks and hold the outer $6\frac{3}{4}$" ring when the drive is engaged. Graphite must be used liberally to prevent the clutch from sticking, but it works very smoothly. The pressure screws are set just tight enough to procure any degree of "drag" desired.

For the setting circles on this instrument, I first tried using a couple of projection circles mounted on masonite disks with the numbers printed on white paper under the circles. These worked after a fashion, but I was never able to get the exact center of the disk; of course, a circle that isn't centered is an abomination. Finally, I designed and made a little machine to draw 9" circles with 720 divisions. I secured printed numbers and sent the layout to an engraver to have cuts made so I could have some printed.

I had supposed that if a cross is marked in the exact center of a circle, it would be easy to bore a hole through that cross. Nothing could be farther from the truth.

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All eyepieces have hard-coated optics and come with metal dust caps. Telestar eyepieces are of the bayonet type and lock securely into an adapter tube with just one-quarter turn. They are made in 11mm., 16mm., and 22mm., focal lengths. All metal parts are black, anodized aluminum.

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So I had to make another machine to put a pilot hole in the exact center. After much further experimenting, I found by accident a plastic-coated hard cardboard on which the circles could be printed. I gave the printed surface a liberal coat of liquid plastic, procuring a surface that looks and feels like celluloid, is washable, and has readable, accurate markings.

The circles are printed on 9½″ square sheets, and a reinforced 9/64″ pilot hole is placed in the exact center. These circles are then pressed to backing boards of ¼″ tempered masonite, held by a good coat of Elmer's glue, which is allowed to dry overnight under pressure. With a jigsaw and sander the circle is cut out, the edge polished and the back and rim painted either with liquid plastic or lacquer. Bronze bushings that exactly fit the axis shafts of the telescope are cut to the proper length. Using the pilot holes, the disk centers are bored with a circle cutter and the bushings inserted in them. These setting circles are available to other amateurs who get in touch with me concerning them.

Pieces of darning needles have been soldered to the tips of the circle pointers; these permit accurate readings and fine adjustments.

As the picture on page 86 shows, the telescope stands on a cement block about 30″ square and about 18″ in depth, to which are fastened steel adjustable lugs. All three legs of the mounting have iron plates bolted to them with notches that fit the lugs. The south and east legs have adjustments for height. The instrument can be taken indoors and reset the next night in its exact position without further adjustment.

With this efficient telescope, I like to pick up 1st-magnitude stars and planets in the daytime. There are always a number that can be found easily and quickly. After the first one is seen and the hour circle set, quite a few more can be observed. One day I had the scope set on Arcturus, when my wife called me in for dinner. More than an hour later, the star was still hanging there in the middle of the eyepiece field.

Teachers often bring groups out to my place for a look at the stars. The drive lets a line of 10 or 15 children have a view without my ever touching the telescope. The hydraulic drive is very simple to operate, and requires no electricity. But the instrument must be perfectly balanced, as the drive is particularly sensitive to any out-of-balance condition.

I have seen all the Messier objects, countless doubles, and nearly all the galactic objects and galaxies listed in Norton's *Star Atlas*. I have a number of eyepieces, but my favorite is a 1¼-inch Erfle wide angle. This is wonderful for nebulae and clusters.

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The major parts are aluminum castings, made of virgin alloy #356, T6 heat-treated. The shafts are solid steel, precision ground to 1½ inches in diameter. The lock collars and bolts are also of steel. The polar and declination axis housings are 2½ inches in diameter and 9 inches long, with 4 inches of bearing on each axis. Cast base is 6 inches in diameter. Can be used on a pier or a sturdy tripod.

It is completely machined and is finished in black crackled instrument baked enamel. The mounting weighs approximately 33 pounds and the counterweight 13 pounds. It will rigidly support a 6- or 8-inch mirror of any focal length and a 10-inch mirror of short focal length. Saddles are available for 7-, 8-, 9½-, and 10-inch diameter tubes. Setting circles and a clock drive are being designed and will be available later.

The mounting, complete as pictured less tripod, is priced at **$66.50** f.o.b.; packing charges are $7.00 extra, and it can only be shipped via railway express or truck freight. Immediate delivery.

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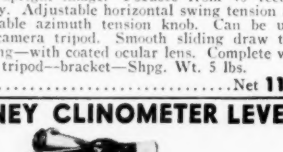

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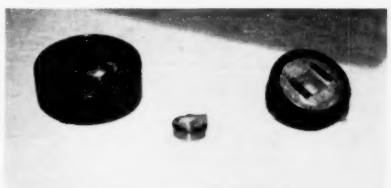
FOR several years I have used a prism in front of the objective of my telescope to show the spectra of the brighter stars. Suitable prisms can be obtained from most optical supply houses, at considerably less cost than eyepiece spectroscopes.

I first used a 2″ by 2″ prism of 20° angle on my 2-inch f/10 refractor. Experiments were also made with a small replica transmission grating with 15,000 lines to the inch: either prism or grating works satisfactorily. I made a metal cover for the telescope objective, cut a hole in it, and fastened the prism over it with Scotch tape.

When I got a 4-inch refractor, I made a cardboard cap to carry the 20° prism, but it was impossible to get a good focus on the spectrum. Then a heavier cap with clips was made, so that prisms could be interchanged for comparative tests. I found that with this telescope, of 48-inch focus, a 10° prism worked best. On a 4-inch reflector of about 30 inches focal length, the best results were with a 15° prism. From this it appears that the longer the focal length, the smaller the angle of the prism should be. In confirmation of this, professional astronomers often use 4° prisms on large telescopes.



Mr. Wright's three prisms are shown here. Left: the large cap for the 4-inch reflector, with the 15° prism mounted off center. Middle: the arrangement for the small refractor. Right: the 10° prism mounted permanently for use on the 4-inch refractor.

Using an arrangement of this sort, I can see the dark Balmer lines of hydrogen in certain star spectra under good conditions. My 4-inch telescope shows spectra of stars as faint as magnitude 5 or 6.

The greatest difficulty in observing with an objective prism is pointing the telescope. To see a particular star, the telescope must be displaced perpendicular to the base of the prism. Usually I first find the star in the telescope, put the prism in place, and then shift the telescope in the proper direction. This is not easy, but can generally be done in a few minutes. It would help to have a small finder on the telescope, offset by the appropriate amount, when the objective prism is used.

G. R. WRIGHT
202 Piping Rock Drive
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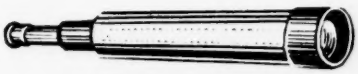
"GIANT" 3-inch TELESCOPE



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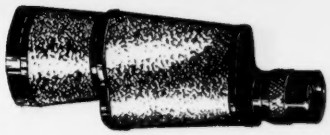

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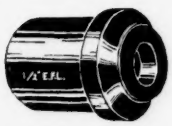

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Diameter	Focal Length	Each	Diameter	Focal Length	Each
54 mm (2⅛")	254 mm (10").....	$12.50	83 mm (3¼")	660 mm (26").....	$28.00
54 mm (2⅛")	300 mm (11.8").....	12.50	83 mm (3¼")	711 mm (28").....	28.00
54 mm (2⅛")	330 mm (13").....	12.50	83 mm (3¼")	762 mm (30").....	28.00
54 mm (2⅛")	390 mm (15.4").....	9.75	83 mm (3¼")	876 mm (34½").....	28.00
54 mm (2⅛")	508 mm (20").....	12.50	83 mm (3¼")	1016 mm (40").....	30.00
54 mm (2⅛")	600 mm (23½").....	12.50	102 mm (4")	876 mm (34½").....	60.00
54 mm (2⅛")	762 mm (30").....	12.50	108 mm (4¼")	914 mm (36").....	60.00
54 mm (2⅛")	1016 mm (40").....	12.50	110 mm (4⅜")*	1069 mm (42 1/16")	60.00
78 mm (3 1/16")	381 mm (15").....	21.00	110 mm (4⅜")	1069 mm (42 1/16")	67.00
80 mm (3⅛")	495 mm (19½").....	28.00	128 mm (5 1/16")*	628 mm (24¾").....	75.00
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*Not coated

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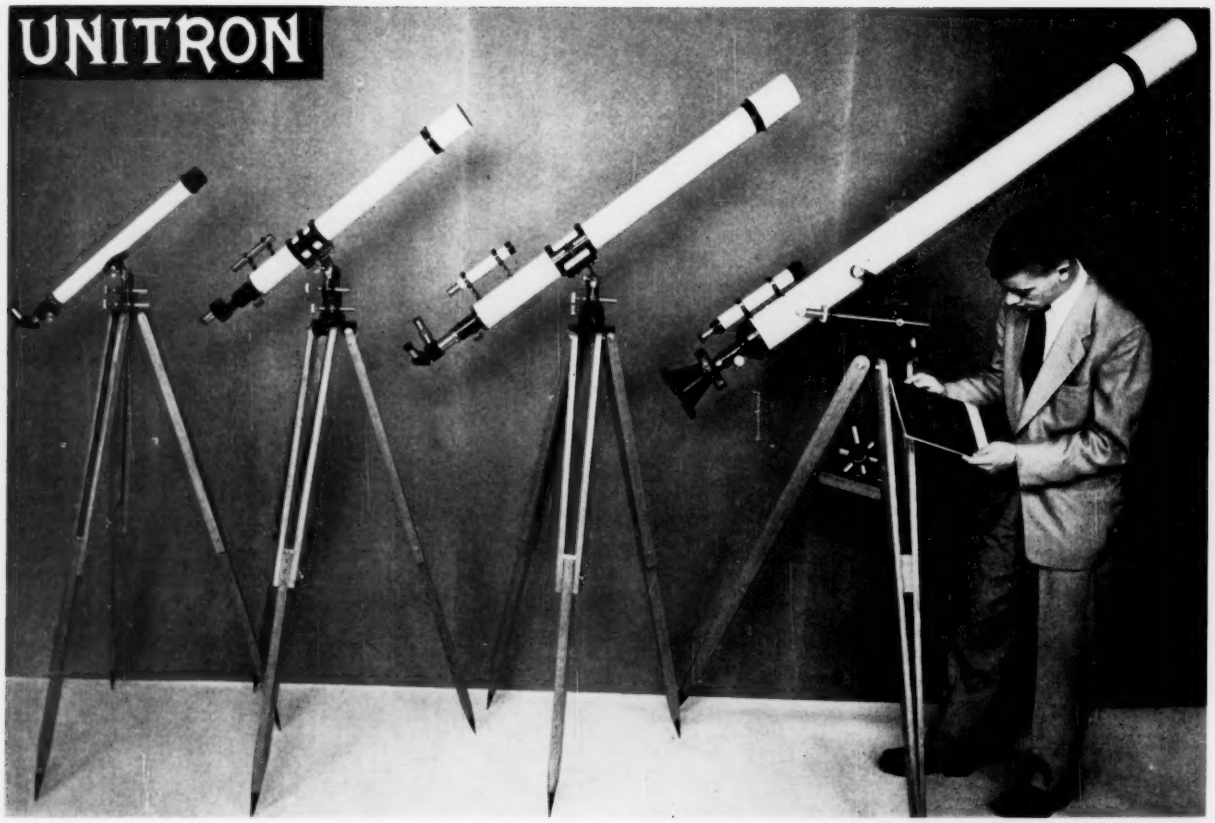
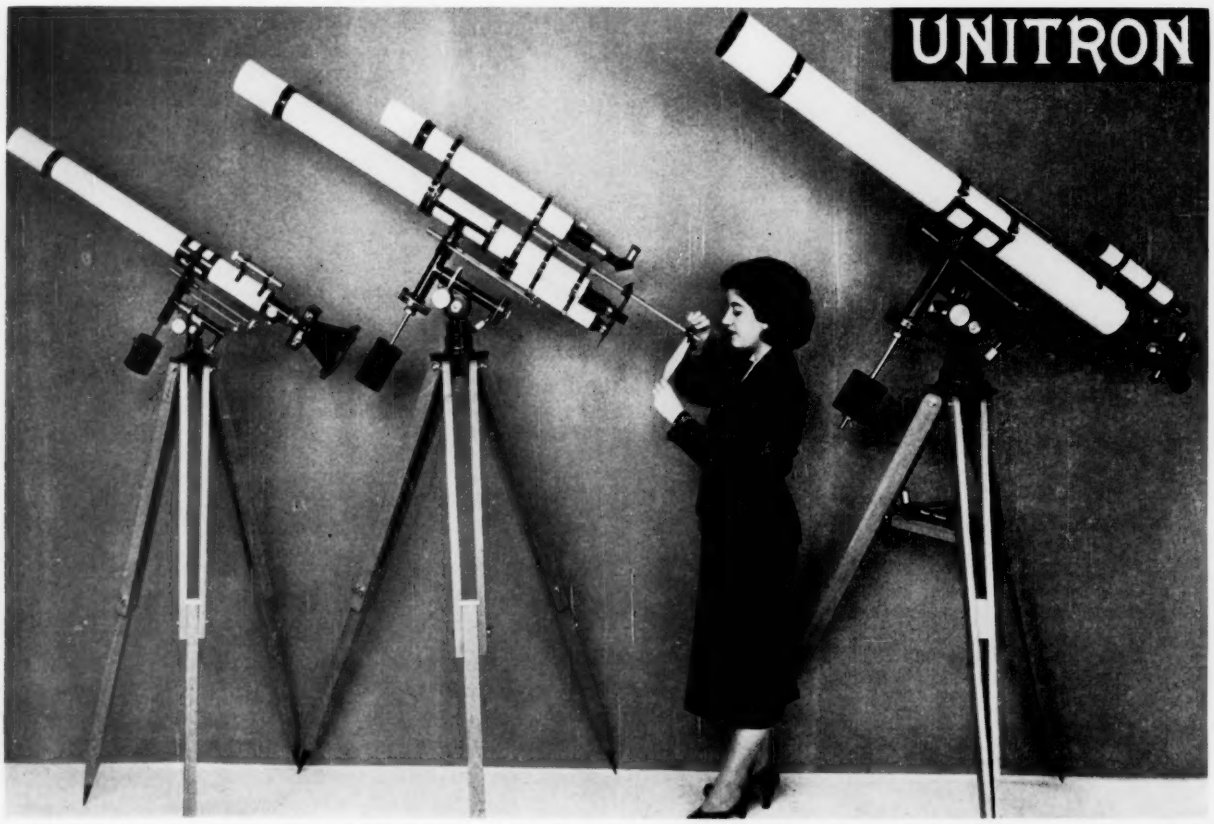


UNITRON Altazimuth Refractors: left to right, 1.6″ (with star diagonal), 2.4″ (with erecting prism system), 3″ (with DUETRON double eyepiece), and 4″ (with astro-camera and UNIHEX on the shelf).



UNITRON Equatorial Refractors: left to right, 2.4″ (with astro-camera), 3″ Photo-Equatorial (with sun screen), and 4″.

For year-round pleasure, give or get a UNITRON this Xmas

MANY Models To Choose From!

Pictured on the left are seven of the eleven models of UNITRONS currently available. The UNITRON line of telescopes and accessories is the completest ever offered.

1.6" ALTAZIMUTH ($19 Down) **$75**
with eyepieces for 78x, 56x, 39x

2.4" ALTAZIMUTH ($31 Down) **$125**
with eyepieces for 100x, 72x, 50x, 35x

2.4" EQUATORIAL ($56 Down) **$225**
with eyepieces for 129x, 100x, 72x, 50x, 35x

3" ALTAZIMUTH ($66 Down) **$265**
with eyepieces for 171x, 131x, 96x, 67x, 48x

3" EQUATORIAL ($108 Down) **$435**
with eyepieces for 200x, 131x, 96x, 67x, 48x

3" PHOTO-EQUATORIAL ($137 Down) **$550**
with eyepieces for 200x, 171x, 131x, 96x, 67x, 48x

4" ALTAZIMUTH ($116 Down) **$465**
with eyepieces for 255x, 219x, 170x, 122x, 84x, 61x

4" EQUATORIAL ($196 Down) **$785**
with eyepieces for 255x, 219x, 170x, 122x, 84x, 61x

4" PHOTO-EQUATORIAL ($222 Down) **$890**
with eyepieces for 255x, 219x, 170x, 122x, 84x, 61x

4" PHOTO-EQUATORIAL with clock drive and astro-camera ($294 Down) with 8 eyepieces **$1175**

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All models come with air-spaced, coated objective; eyepieces; duraluminum tube; rack-and-pinion focusing; view finder; sunglass; star diagonal; tripod; mounting; cabinets; instructions; and standard accessories. Additional eyepieces and accessories available for all models. Choice of UNIHEX Rotary Eyepiece Selector or star diagonal and erecting prism system for terrestrial observation in all models except the 1.6".

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The UNITRON Easy Payment Plan is a convenient and economical way to buy your UNITRON Refractor when you do not want to disturb your savings or when you haven't the total cost of the telescope immediately available. The down payment required is 25%. The balance due is payable over a 12-month period, and there is a 6% carrying charge on the unpaid balance. Your first payment is not due until 30 days after you receive the instrument, and if you should want to pay the entire balance due at that time, the carrying charge is canceled.

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Send check or money order in full or use our Easy Payment Plan, as described above. Shipments made express collect. Send 20% deposit for C.O.D. shipment. All instruments are stock items and Christmas orders will be shipped the same day as received. For special rush orders and information, telephone HAncock 6-9878 (Boston exchange) and ask for "Christmas Order Department."

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1. **VIEW FINDER** (As shown on UNITRON 2.4" Equatorial): 23.5-mm. (.93") achromatic objective, 6x eyepiece with crosshairs. Chromed brass tube. Mounting brackets with centering screws.
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ASTRO-CAMERA 220: Complete with air-operated curtain shutter, giving speeds of 1/10 to 1/90 second, bulb and time, shutter release, ground-glass back, 3 double plateholders for 3¼" x 4¼" plates or cut film, a 30-mm. f.l. eyepiece, extension tubes and clamps, and a fitted wooden cabinet. Model A is designed to fit the UNITRON rack and pinion and is for UNITRONS only. Model B fits 1¼" eyepiece holders. A or B:
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EQUATORIAL MOUNTING and TRIPOD: Complete with slow-motion controls for both declination and R. A., setting circles and verniers, and many other features.

As used on UNITRON 3" Refractor **$198**
As used on UNITRON 4" Refractor **$370**

(These prices are f.o.b. Boston)

You Will Want the *New* UNITRON CATALOG

The UNITRON publications staff is rushing completion of an exciting new catalog. Those who have seen the advance copy and photographs are unanimous in their agreement that it is no less than the most informative, most elegant, and completest catalog of its kind ever issued. This is a strong statement indeed — but it only conveys a portion of our own enthusiasm for this unique publication.

A particularly interesting feature of the new catalog will be a series of *illustrated* articles of general astronomical interest containing information not easily accessible elsewhere. The subjects covered will include the constellations, observing the sun, observing the moon, observing the planets, interesting sky objects, hints on observing, amateur club and research programs, a glossary of telescope terminology, information on types of telescopes, mountings, accessories, and the like. All UNITRON models will be illustrated by large, 8"-by-10" closeup views and all of the new accessories will be shown in use on the instruments. This new catalog will be a valuable reference work and worthy of a permanent place on your bookshelf.

If you have requested our telescope literature on any previous occasion, your name is on our mailing list and you will automatically receive a copy of the new catalog as soon as it is ready. If you have not yet requested literature from us, we suggest you write at once. If the new catalog is not ready for distribution at the time of receipt of your inquiry, we will send you in the meantime our present "Telescope Buyer's Kit" with the new catalog to follow as soon as possible. Send no money, send no stamps, merely address a letter or post card to our Catalog Department.

Here's the UNITRON "Tri-Power" 20x, 30x, 40x Terrestrial Telescope

The UNITRON 60-mm. "Tri-Power" is the ideal portable telescope for nature study, bird watching, vacation trips, sports events, viewing the moon, and for use whenever you want a real closeup view of a distant object.

With the new Triple Revolving Eyepiece Selector, the observer chooses the desired magnification of 20x, 30x, or 40x, by merely rotating an eyepiece turret. There is now no need to be restricted by a telescope with only a single power or to one with individually changeable, easily misplaced eyepieces. The telescope tube is made of lightweight duraluminum and finished in white enamel. With the large 60-mm. (2.4") coated objective, brilliant sharp images are obtained even with dim lighting. Focusing is easy and foolproof with the micromatic rack-and-pinion knob.

A sturdy three-section tripod, adjustable from 36 to 60 inches, and mounting is included—there is no need to buy this costly extra.

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Ocular bodies of machined brass, nickel plated, 1¼ inches in diameter. Optics fully coated and quality is unconditionally guaranteed.

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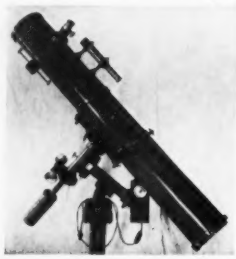
Complete Telescopes

6" as illustrated $660



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FRANK GOODWIN
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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

SOME AMATEUR PHOTOGRAPHS OF PERSEID METEORS

ON August 10-12, the Regina Astronomical Society carried on observations of the Perseid meteor shower, as it has done in the past. This year we were extremely fortunate. On the first night 117 meteors were logged; on the next night 299 were recorded and I obtained one good meteor photograph.

A maximum effort on the night of August 12th saw a full set of observers, three cameras (one with a spectrograph), and one man plotting meteors at Regina; and a two-man plotting team was at B-Say-Tah, 40 miles away. The result was 425 meteors logged, two photographed and 37 plotted by myself, one spectrogram by John Hodges, and some 40 meteors logged and plotted at B-Say-Tah by Gordon and Gerald Bitney. For one meteor on August 12th we secured a photograph, a spectrogram, and two plots!

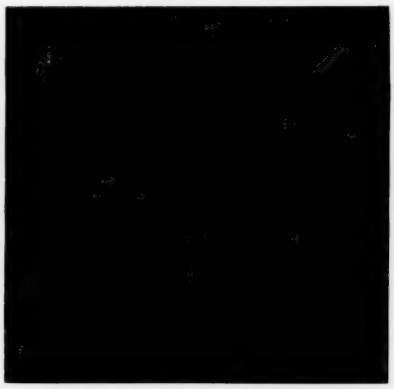
The complete records are being sent to Dr. Peter Millman, of the National Research Council, Ottawa, for analysis.

GORDON R. THOMPSON
1136 Elphinstone St.
Regina, Sask.

On August 11th, just before the maximum of the Perseid meteor shower, I took the accompanying photograph with a 50-mm. f/3.5 Argus camera. This exposure of the nearly overhead sky was from 1:18 a.m. EST to 1:30. At 1:29 a Perseid as bright as Vega was seen and photographed, white and very swift, leaving a trail visible for about 30 seconds.

I used Eastman Tri-X 35-mm. film, whose speed was increased to 800 by 20-minute development in Kodak Microdol at 72° Fahrenheit.

HAROLD POVENMIRE
953 Studer Ave.
Columbus 6, Ohio



The Perseid meteor trail photographed by Harold Povenmire is shown here. The short lines are the trails of stars made during the 12 minutes the shutter was open.

Parts of two of Mr. Thompson's photographs on the night of August 12-13 have been joined to show two meteors from the Perseid radiant. The lengths of the star trails are not the same because of unequal exposure times.

DECEMBER METEORS

New moon on December 14th will provide dark skies for observation of the Geminid meteor shower this year. Appreciable numbers of these meteors may be seen several days before and after maximum on the 13th, when up to 40 per hour should be visible under good conditions. The best time to observe the shower is before midnight. Geminids are

The British Astronomical Association

Founded 1890, now 2,000 members
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Chief objects are mutual assistance in observation, and circulation of astronomical information. Publications: *Journal*, about 8 times yearly; *Annual Handbook; Circulars* giving astronomical news; *Memoirs* of the Sections (Sun, Moon, Planets, Comets, Aurorae, Meteors, Variable Stars).

For further particulars write

The Assistant Secretary, B.A.A.
303 Bath Road, Hounslow West, Middlesex, England

of medium speed and radiate from a point near Castor at right ascension 7h 32m, declination +32°.

The December Ursids appear only on the night of December 22-23, with a maximum predicted rate of 15 meteors per hour. They are best observed after midnight when the moon has set. The radiant is at 13h 48m, +80°.

E. O.

MAP OF THE MOON

A very frequent question among telescope users is where an inexpensive and handy yet fairly detailed chart of the moon can be obtained. Many amateurs may like the recently published new edition of T. G. Elger's *Map of the Moon*, revised by H. P. Wilkins. It is 17½ inches in diameter, and contains several hundred named craters.

Dr. Wilkins' revisions consist mainly in the addition of much small detail and more crater names. A number of the latter are designations not yet accepted by the International Astronomical Union. There are a few errors in crater names, such as Sine for Sina, and Pulisa for Palisa.

This map is published in England by George Philip and Son Ltd., 30-32 Fleet St., London E. C. 4.

OCCULTATION PREDICTIONS

December 25-26 **Delta Arietis** 4.5 3:09.1 +19-33.5, 12, Im: **A** 1:23.6 −2.5 −1.9 124; **B** 1:17.7 −2.0 −0.6 110; **C** 1:20.1 138; **D** 1:06.8 −2.1 −0.4 110; **E** 0:43.7 −1.9 +0.3 106; **F** 0:31.5 −2.6 −1.2 127; **I** 0:32.5 −0.1 +2.1 45.

December 26-27 **Kappa Tauri** 4.4, 4:22.7 +22-11.6, 13, Im: **A** 6:28.4 −1.3 +0.1 54; **B** 6:28.2 −1.4 +0.7 42; **C** 6:23.0 −1.3 −0.3 70; **D** 6:19.3 −1.4 +0.2 56; **E** 6:01.7 −1.7 −0.2 77; **F** 5:55.9 −2.0 −1.5 112; **H** 5:05.4 −2.0 +0.5 87; **I** 5:20.6 −1.1 +2.7 37.

December 30-31 **Alpha Cancri** 4.3, 8:56.0 +12-02.0, 17, Im: **H** 13:55.7 −0.7 −1.8 122; **I** 13:31.5 −0.9 −1.4 102. Em: **I** 14:31.8 −0.4 −1.9 309.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo** − **LoS**), and multiply **b** by the difference in latitude (**L** − **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

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About a year ago we heard of the problems several groups were having in securing hemispherical screens for planetarium chambers, fabricated and completely installed by a single contractor. To explore the need for such a service, we have spent the past year visiting most of the major planetariums throughout the country, discussing with the directors and engineers their methods of installing interior planetarium domes. Fortified with their answers and an exhaustive study by our own engineers, ASTRO-DOME is now ready to offer you a complete planetarium screen, permanently installed in your own chamber.

The new ASTRO-SCREEN can be built in any size from 20 to 60 feet in diameter. It is, therefore, equally suitable for installations with small and large projectors, from the Spitz Junior to the largest Korkosz, Spitz, or Zeiss. The screen is made of spun aluminum sections, 1/16-inch thick, and it is perforated to insure proper acoustics in the chamber. Its suspended construction within a steel frame (which is an integral part of our design and fabrication) makes it readily accessible for maintenance and the mounting of exhibits viewed through the perforations. The hemispherical shape can be maintained to a high degree of accuracy. It can be painted or plastic-coated to any finish.

All ASTRO-SCREENS are prebuilt for inspection before shipment. Our engineers and construction crews, who are men with an astronomy background, will install your screen with guaranteed satisfaction.

Write, wire, or phone now for further information. We will be glad to give you a no-obligation estimate to fit your specific needs.

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THE DIFFERENTIAL METHOD OF USING SETTING CIRCLES

SOME OBSERVERS say that the difficulty in perfectly lining up the polar axis makes it a waste of time to equip a portable telescope with setting circles. However, with the circles on my 4¼-inch reflector I can locate an object in less than a minute. This is because I apply the differential method, which also has the advantage of avoiding the use of sidereal time.

How would you describe the location of some small town in Arkansas? Would you say it was so many miles south and west of New York City, or would you be more likely to refer its position to Little Rock or Hot Springs? The same reasoning, for the amateur's purposes, can be applied to the sky.

Suppose you wish to locate the famous Ring nebula, M57 in Lyra, which has a right ascension of $18^h\ 51^m.8$ and a declination of $+32°\ 58'$. A star atlas, such as Norton's, will show that the nebula is located south and east of Vega, for which star catalogues give a position of $18^h\ 35^m.2$, $+38°\ 44'$. By simple subtraction, you can calculate that M57 is 16.5 minutes east and nearly six degrees south of Vega.

Now put a low-powered eyepiece in your telescope and get Vega in the center of the field. Then, by means of the circles, swing the telescope $16^m.5$ east and 6° south. Look in the eyepiece. If sky transparency and the light grasp of your telescope permit, M57 will be visible in the field.

It is important that you do not take too long to shift from the known to the unknown object. I find that it generally takes me about 30 seconds to make the adjustments. Therefore, I set the telescope about 30′ west of the calculated spot, and the extra half a minute is taken care of by the rotation of the earth.

The first time I tried this method, in June this year, I prepared a list of likely objects and their distances from convenient reference stars. In little more than an hour I had located and observed nine Messier objects in various parts of the sky. In no instance was it necessary for me to hunt for the object—it was always in the field at first glance.

You may wonder just how accurately I line up my polar axis. If my telescope tube is parallel to the polar axis and the declination axis is roughly pointing at the meridian, then I adjust the tripod legs until I see Polaris in the field of a low-powered eyepiece. No more accuracy than this is necessary.

However, the less accurate the alignment of the polar axis, the closer the reference star should be to the object you are trying to find. The inexpensive pocket-sized *Handbook of the Heavens* lists Messier objects, as well as bright stars to fainter than the 2nd magnitude. With this book, I have had to use Arcturus for locating M5 in Serpens Caput, although this involved distances of an hour in right ascension and some 17 degrees in declination. Nevertheless, I located M5 on the first try.

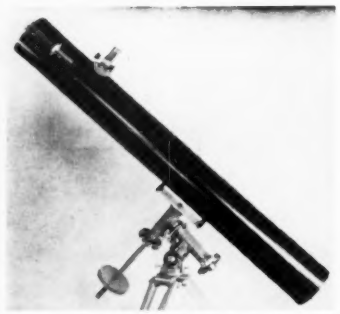
WILSON DOTY
447 Blue Rd.
Coral Gables, Fla.

MOON PHASES AND DISTANCE

Last quarter	December	6, 08:35
New moon	December	14, 07:07
First quarter	December	22, 09:39
Full moon	December	29, 03:44
Last quarter	January	4, 22:41

	December	Distance	Diameter
Apogee	15, 07h	252,600 mi.	29′ 24″
Perigee	29, 00h	221,500 mi.	33′ 31″
	January		
Apogee	11, 08h	252,600 mi.	29′ 24″

THE NEW GARTHOSCOPE 6-INCH REFLECTOR



- 6-inch Pyrex parabolic mirror correct to ⅛ wave. Aluminized and quartz coated.
- Rack-and-pinion focusing.
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6″-$7.00 8″-$11.50 10″-$35.00

EYEPIECE ATTACHMENT WITH RACK AND PINION

Takes standard 1¼″ O.D. eyepieces. Rack and pinion smoothly machined from solid aluminum castings. Precisely fitted for smooth performance. Main tube is 1¾″ long; sliding tube adds 2″; total movement 3¾″. Your choice of gray or black crinkle finish.

$15.50

BUILD YOUR OWN TELESCOPE

Prisms Lenses Eyepieces
Mirrors ground to your order.
Aluminizing—with Quartz Coating
Satisfaction Guaranteed
Write for Free Catalog

GARTH OPTICAL COMPANY
P. O. Box 991 Springfield 1, Mass.

On the opposite page are reprinted the next four pages of the Questar booklet. More will follow in succeeding advertisements. The entire booklet is available upon request.

A 'SCOPE IN THE HAND IS WORTH TWO IN THE ATTIC

The Questar idea is simply this — when a telescope is very fine, extremely versatile, and always convenient to use, its owner will use it constantly with great pleasure and satisfaction.

The soundness of this idea is proven daily. People take Questars wherever they go and use them all the time. They tell us they have never enjoyed any instrument so much or used one so frequently in so many ways.

It is not surprising that we often sell a Questar to the owner of one or more single-purpose telescopes. In a very real sense, however, we do not think that we sell Questars at all. Actually they sell themselves, first on the basis of their most impressive and beautiful performance, and second, because their many uses make them the best long-term investments in all-round observing enjoyment.

The DeLuxe Questar, complete with all accessories in handmade English case, is priced at $995. Your check for $200 will reserve an instrument.

QUESTAR CORPORATION
NEW HOPE, PENNSYLVANIA

Questar

The First Safe And Distortionless Solar Telescope

Since Galileo, men have tried to study details of the great sunspots that wax and wane, and wheel from day to day across the dazzling face of the nearest star, our sun. During his lifetime, the solar disc was viewed by projecting its image upon a white card or screen from the eyepiece of the telescope. This primitive method is lacking in sharpness, and the intense beam that must traverse the eyepiece lenses, although excellent for lighting cigarettes, quickly ruins the cemented doublets of modern highly corrected eyepieces by boiling out the cement. Thus, none but the eighteenth century eyepieces of Huygens or Ramsden types could be used, whose single lenses suffered less from heat.

The sun is best seen by direct observation. This method depends on some arrangement to keep the blinding light and heat from entering the observer's eye. Previous dispersion or absorption devices have always been applied near the very hot "burning glass" image of the sun at the focal point of telescopes. Not many astronomers ever thought to diminish the solar radiation save *after* it had passed through most of the instrument, warping lenses or mirrors, heating trapped air within the tube, and sometimes damaging not only eyepieces, but observer's eyes as well, for dark-glass filters have been known to break from heat.

It has remained for Questar to produce a simple filter which keeps the harmful concentration of heat from entering the telescope at all. It completely shields the instrument from all the solar radiation, except one part out of fifty thousand. Questar's solar filter consists of a measured thickness of chromium metal deposited on glass, which is placed over the front lens. It rejects the sun's radiation by reflecting it away instead of absorbing it, thus both filter and telescope stay quite cool to the touch on the hottest day. The choice of chromium is a happy one, for since its transmission curve in the visible spectrum is practically a straight line, all colors are truly seen at their reduced intensities. Its extreme surface hardness resists abrasion, so that it requires no special care.

The sun's face may now be studied with Questar in safety, comfort and steadiness of detail previously unknown. Since Questar is prevented from warming to the task, no internal convection currents or warped optical surfaces are set up to spoil otherwise good seeing. The gain in steadiness and clarity of image is at once apparent. By not falling off after the first few minutes, this sharpness serves to demonstrate how much of the poor seeing experienced in solar work actually originates within the tubes of conventional instruments themselves. The highest powers may be used at unimpeded peak performance with Questar for extended periods of observing.

Questar's synchronous electric drive again provides the final touch of luxury for observing. It keeps the sun's image quietly immovable in the field of view. This feature alone makes group demonstration and group observing practical and simple, for without automatic following, the instructor formerly was kept busy adjusting for each student, who often got little more than one fleeting glimpse of a moving object. Classroom astronomy at regular daytime hours now becomes easy and convenient.

A Perfect Telephoto Lens

Not only will Questar photograph everything that can be seen through it, but it will do so in a variety of ways. No color filters or supplementary lenses are required. Its direct primary image may be used upon the smaller films, and eyepiece projection may be used for negatives of great size.

Addition of merely a ground glass, filmholder and shutter, makes Questar a complete telephoto camera with the enormous focal length of 42 inches (1070 mm.) working at f:12. It may be focussed down to the fantastically close distance of approximately twice its own focal length. The 35 mm. camera body to be preferred is one of the single lens reflex type, with focal plane shutter.

No supporting cradles or mountings or focussing jackets are required, since Questar is already elegantly mounted with slow motions and a clamp in altitude.

Unlike ordinary telephoto lenses, no special setting needs to be estimated for infra-red work, for there is no chromatic aberration. There is no secondary and no lateral color. There is no coma, astigmatism, nor distortion.

In all instances, the performance is superior to existing telephoto lenses because Questar's optical system approaches much more closely the theoretical perfection of definition, actually achieving the physical limit of resolution as defined by Lord Rayleigh on the basis of the Airy disc. Unlike camera lenses, which provide sharper images by using reduced apertures to minimize their faults, Questar offers higher resolving power with increased aperture. This means that there is no need to "stop down" for critical sharpness when photographing with Questar. Both light-grasp and definition are at the maximum simultaneously, a new experience for the user of photographic lenses.

A Terrestrial Viewing Scope And Spotting Scope

Questar is unquestionably the finest telescope ever offered for terrestrial observing. Heretofore the great size and weight of the astronomer's long-barrelled instrument have kept its superior abilities from being much enjoyed in this pursuit, as did its inverted and reversed views.

Now the full powers of such telescopes are at our command in an instrument scarcely larger than a telephone, which shows everything correctly right side up as a matter of course. Standing less than 9½ inches high, Questar was designed for desk or tabletop, and to fit into any bookshelf. Placed upon a mantel, it is more than an elegant conversation piece—it is a good companion.

By keeping Questar always ready and at hand, we are free to use it easily and often, as our fancy or events suggest. For one thing, we are then able to swing it into action before the bird has flown, or the parade has passed. For another, there is now no packing or unpacking that might tend eventually to spoil our pleasure. There is a sensible and very human tendency at first to postpone, and finally stop using altogether, any instrument whose setting-up and taking-down involves a lot of work. Now Questar has removed the work, and what is left is sheer enjoyment.

How can we explain to those whose experience with telescopes may have been limited to field glasses, just what Questar's great powers of magnification really mean? The chief thing, of course, is that the view is narrow and the object seems very near. The bird, the flower, the leaf or child a hundred yards away, is crisply seen as though within our reach. We read a watch at a thousand feet, and plainly pick out wasp from fly and bee. Wherever we turn in the country landscape, nature reveals a thousand secret faces, and new surprises daily await our eyes. In all this astonishing wealth of detail it is so easy at high powers to get lost, that we often need the finder to locate our close-up scene. And one never quite gets used to seeing objects clearly that have totally escaped the naked eye.

The city dweller also has no lack of splendid views; indeed, he may have several vantage points from which to look. Perhaps there is a harbor to explore. Everywhere the tasks of men go on, and then, after dark, when lights come on, the textures of drab things acquire distinction, as light and shade create another town.

For target shooting, Questar has no equal. At the private range of Mr. Walter Stocklin, a distinguished marksman, not only were bullet holes in the black well seen, but small print and handwriting were clearly read at distances up to 300 yards, a feat Mr. Stocklin found astonishing and quite beyond the grasp of conventional instruments. Questar's magnification of 160 diameters presented a view of the 900-foot target as though it were but 5 feet 6 inches distant from the eye.

The New Long-Distance Microscope

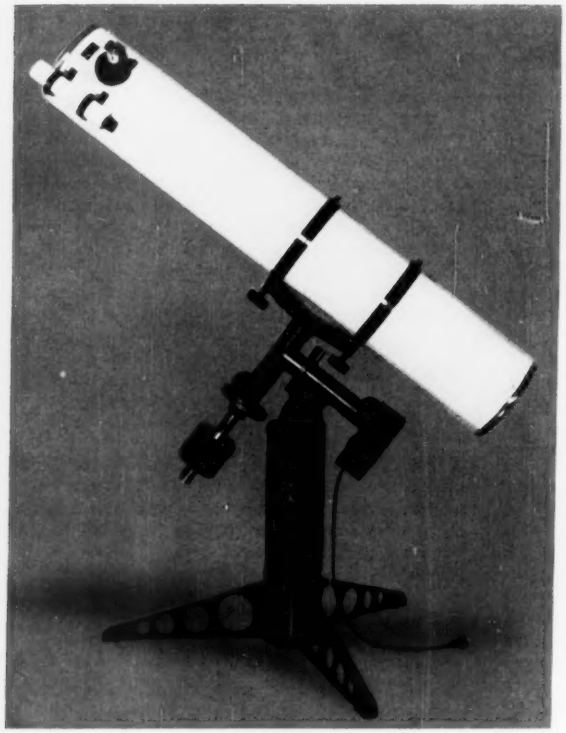
The long-distance microscope, a wholly new and previously unknown optical instrument, is now available in Questar. A new experience awaits both expert and amateur, for Questar can be continuously focussed all the way from infinity down to 7 feet. The exquisite definition of a superb astronomical telescope can be turned with startling effect upon all objects in this astounding range.

Conventional instruments are physically limited to viewing objects no nearer than several hundred feet. A 3½-inch refractor would require a tube a dozen feet long, to focus at 7 feet. To cap this absurdity, it would also need a new lens. Even binoculars or low-powered spotting scopes are seldom able to focus on things closer than 30 or 40 feet. Questar's exclusive internal optical leverage system with fixed eyepiece permits the exploration of the near with such tremendous powers, that here, for the first time, is a microscope that works at a distance.

The result is invariably thrilling, even to the most experienced persons. Lowly weed tops become symmetrical bouquets, the bee at the wild-flower is a monster of terrifying size, the fledgling suddenly appears mere inches from the eye, each hair and feather razor sharp and crystal clear. The naturalist will now be able to secure close-up views or pictures of wild life from distances that do not alarm the animals or birds, and without recourse to stalking blinds or remote control cameras.

Industry will discover many uses for Questar. Standing safely on the ground, the exact condition of elevated structures hundreds of feet high may be examined or photographed in color by the steeplejack or rigger. Dangerous processing may be minutely watched from hundreds of feet away, meters and gauges read as clearly as though they were but two feet distant, instead of 320, matter at white hot temperature may be studied from remote positions, and interior walls of long hollow structures may be examined inch by inch.

TO BE CONTINUED



New De Luxe ASTROLA Model "B"

ASTROLA

Reflecting Telescopes

AMERICAN MADE

Here is the new Model "B", 8-inch De Luxe ASTROLA telescope for those who wish the extras and refinements usually found in the permanently mounted telescopes.

This model has a fiberglass rotating tube, setting circles in both right ascension and declination with verniers, synchronous electric clock drive, rack-and-pinion focuser, large 8x, 38-mm. finder, three of the finest orthoscopic oculars giving powers of 84x, 210x, and 360x. There is a cast aluminum head with 1½" solid steel shafts, adjustable head for change of latitude, and a large 6" diameter stand with cast aluminum legs.

The telescope is portable — weighing about 85 pounds. It may be dismounted or assembled in about three minutes, making it convenient for transporting and storing. The mirror and diagonal are of pyrex, aluminized and quartz overcoated, optically good to ⅛ wave length and guaranteed to resolve doubles to Dawes' limit on good seeing nights.

DE LUXE MODEL "B", 8-inch Complete **$575.00**

NEW RICHEST FIELD

We are now offering a new Richest Field 6-inch ASTROLA, 24" focal length, with one fine 28-mm. ocular. The tube is 26 inches long and the telescope may be cradled in the arms for observing.

Price without mounting **$125.00**

If your mirror is not giving satisfactory performance, we will correct and refigure it, have it aluminized and quartz coated, and furnish a diagonal to go with it, for a very reasonable price. The usual cost for a 6-inch mirror, if no grinding is required, is $35.00. We guarantee the finished mirror to resolve doubles to Dawes' limit on good seeing nights.

All prices F.O.B. our plant, Long Beach, Calif., and subject to change without notice.

TERMS: One half with order, balance when shipment is ready. California residents, add state tax.

Prices for Standard Telescopes:

MODEL "A", 6-inch **$295.00**
With powers of 72x, 180x, and 315x

MODEL "B", 8-inch **$375.00**
With powers of 84x, 210x, and 360x

Clock drive and setting circles available for above:

Clock drive **$70.00** Circles **$60.00**

ASTROLA REFLECTORS WITHOUT MOUNTING, all assembled, painted, ready to use, and consisting of fiberglass tube, cell, spider, rack-and-pinion focuser, finder, pyrex mirror and diagonal, with three orthoscopic oculars:

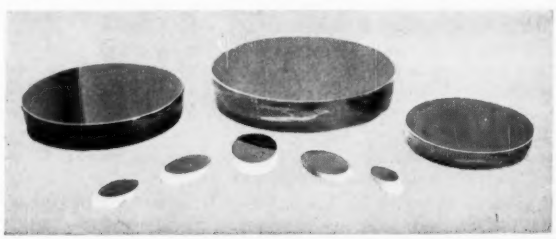
MODEL "A", 6-inch **$197.50**

MODEL "B", 8-inch **$260.00**

Prices on larger permanently mounted scopes quoted on request.

PARABOLIC TELESCOPE MIRRORS AND FLATS

More than 400 of our mirrors are now in service in 40 states and foreign countries. A CAVE MIRROR has become a symbol of fine optical quality and excellent performance.



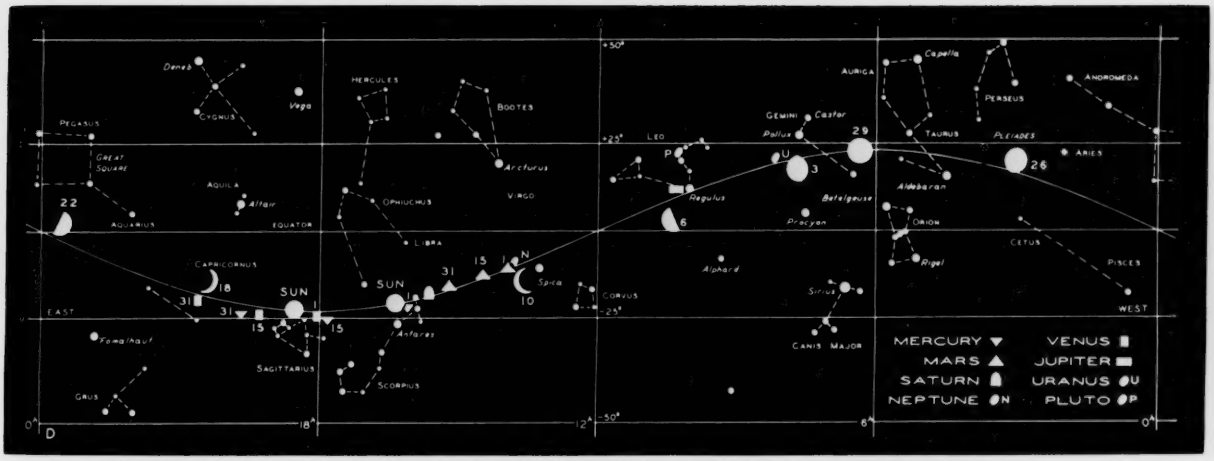
F/8 mirror and diagonal pyrex, aluminized, quartz coated, corrected to ⅛ wave. Other focal ratios slightly higher.

6" ..... $60.00 8" ..... $92.50 10" ..... $160.00 12½" $250.00

Focusers, spiders, cells, finders, tubes, diagonals, and other parts sold separately. Write for price list.

CAVE OPTICAL COMPANY

4137 E. Anaheim, Long Beach 4, Calif.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Sun. The sun will be eclipsed on December 14th, for observers in portions of the Eastern Hemisphere. This eclipse will be of the annular type, with greatest duration of annularity 12 minutes 9.3 seconds, occurring unfortunately over the ocean. The path begins in Africa, crosses the Indian Ocean and Thailand, ending in Formosa.

Mercury enters the evening sky on December 4th, passing superior conjunction with the sun. It will be visible by the end of the month, setting one hour after the sun, appearing at magnitude −0.7.

Venus becomes a prominent object in the southwest as it sets after evening twilight in the latter half of the month. Shining at a brilliant −3.3 on the 15th, the planet as viewed in a telescope appears 90 per cent illuminated, with a diameter of 11″.5.

Earth arrives at heliocentric longitude 90° on December 22nd at 15:12 UT. Winter commences in the Northern Hemisphere and summer in the Southern.

Mars can be viewed in the morning sky, rising 3½ hours before the sun in midmonth. Appearing as a red object of magnitude +1.8, Mars is moving eastward in Virgo and Libra.

Jupiter rises four hours after sunset by the end of the month, shining at magnitude −1.9. The giant planet begins retrograde motion on December 18th, when it is just east of Regulus. The Jovian disk, 40″ in equatorial diameter in midmonth, is discernible in a small telescope.

Saturn may first be viewed in the morning sky at the beginning of December, rising an hour before the sun. By the end of the month, this interval will increase to three hours. The planet is moving eastward in Libra, at magnitude +0.8.

Uranus, in retrograde motion in western Cancer, rises during the evening. This 6th-magnitude object is at 8h 16m.6, +20° 20′ (1955) on the 15th.

Neptune rises about 2 a.m. local time at the end of the month, and with binoculars can be located in Virgo. For a map of its path, see page 169 of the February, 1955, issue.

E. O.

MINIMA OF ALGOL

December 3, 19:07; 6, 15:56; 9, 12:45; 12, 9:34; 15, 6:23; 18, 3:12; 21, 0:01; 23, 20:50; 26, 17:39; 29, 14:28. January 1, 11:18; 4, 8:07; 7, 4:57; 10, 1:46.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

SUNSPOT NUMBERS

September 1, 85, 89; **2,** 86, 88; **3,** 96, 80; **4,** 92, 85; **5,** 83, 78; **6,** 75, 70; **7,** 69, 74; **8,** 78, 68; **9,** 67, 61; **10,** 53, 52; **11,** 38, 40; **12,** 36, 40; **13,** 30, 40; **14,** 27, 33; **15,** 38, 46; **16,** 30, 25; **17,** 35, 38; **18,** 29, 41; **19,** 28, 29; **20,** 9, 23; **21,** 3, 7; **22,** 1, 0; **23,** 4, 7; **24,** 23, 25; **25,** 15, 30; **26,** 12, 11; **27,** 20, 21; **28,** 12, 12; **29,** 15, 9; **30,** 31, 32. Means for September: 40.7 American, 41.9 Zurich.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by D. W. Rosebrugh from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

VARIABLE STAR MAXIMA

December 7, S Pavonis, 194659, 7.3; 13, R Corvi, 121418, 7.6; 14, T Centauri, 133633, 6.1; 22, R Leonis, 094211, 5.9; 24, R Octantis, 055686, 7.9; 26, X Ophiuchi, 183308, 6.9; 29, S Sculptoris, 001032, 6.8; 30, RT Cygni, 194048, 7.4. January 9, Omicron Ceti, 021403, 3.7.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

NEW - NEW - NEW

Star Time Calculator

Handy slide-rule type calculator enables you to obtain sidereal time in a matter of seconds. Good for any longitude, day of the year, standard time zone, and time of day. Accuracy to within several minutes is more than adequate for setting-circle use. Printed in two colors on sturdy 10″ x 3½″ cardboard. Reverse side lists 39 major star clusters and nebulae.

A useful tool for all who are interested in astronomy. Satisfaction guaranteed.

$1.00 postpaid

STAR TIME CALCULATOR

RR 2, Box 375, Buchanan, Michigan

SKY-SCOPE

COMPLETE AS ILLUSTRATED $29.75

The full 3½-inch diameter reflecting type astronomical telescope that even the telescope makers talk about.

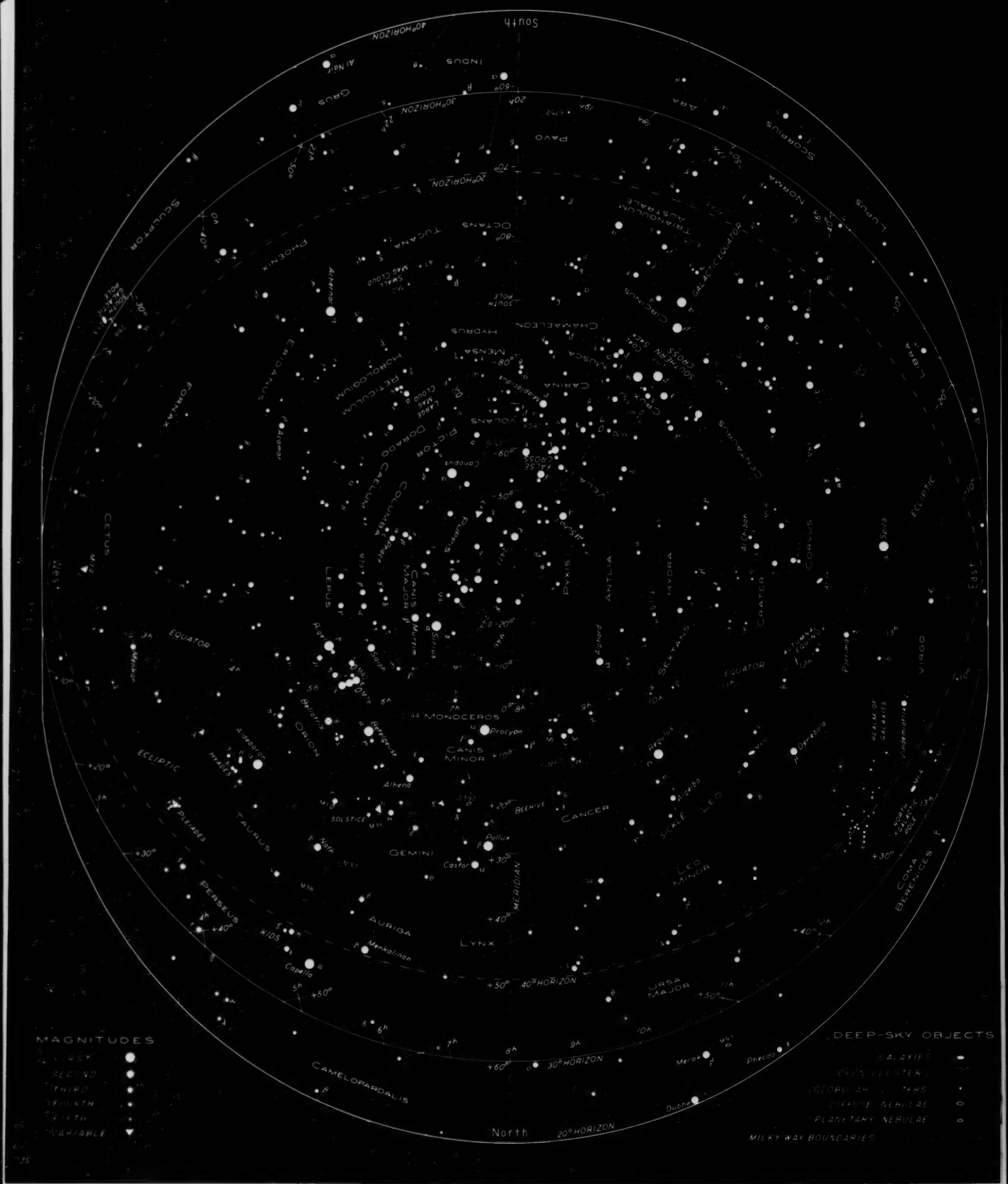
It has been sold for more than 16 years and now is on display in at least two U. S. planetaria. It will show mountains and craters on the moon, Saturn's rings, Jupiter's four moons and the planet's markings, and close double stars with guaranteed observatory clearness. Skyscope enjoys worldwide distribution.

Every instrument, with its ¼-wave, aluminized mirror, is individually tested before being packed for shipment. We suggest that before buying you inquire at almost any local astronomy society about the efficiency of Skyscope. *100% American-made.*

We invite your attention to our free and straightforward descriptive brochure which also shows a photograph of the individual parts used.

125-power and 35-power extra eyepieces	**$5.15 each**
Six-power finder, with brackets	**$7.50**
Holder for extra eyepieces	**$1.00**

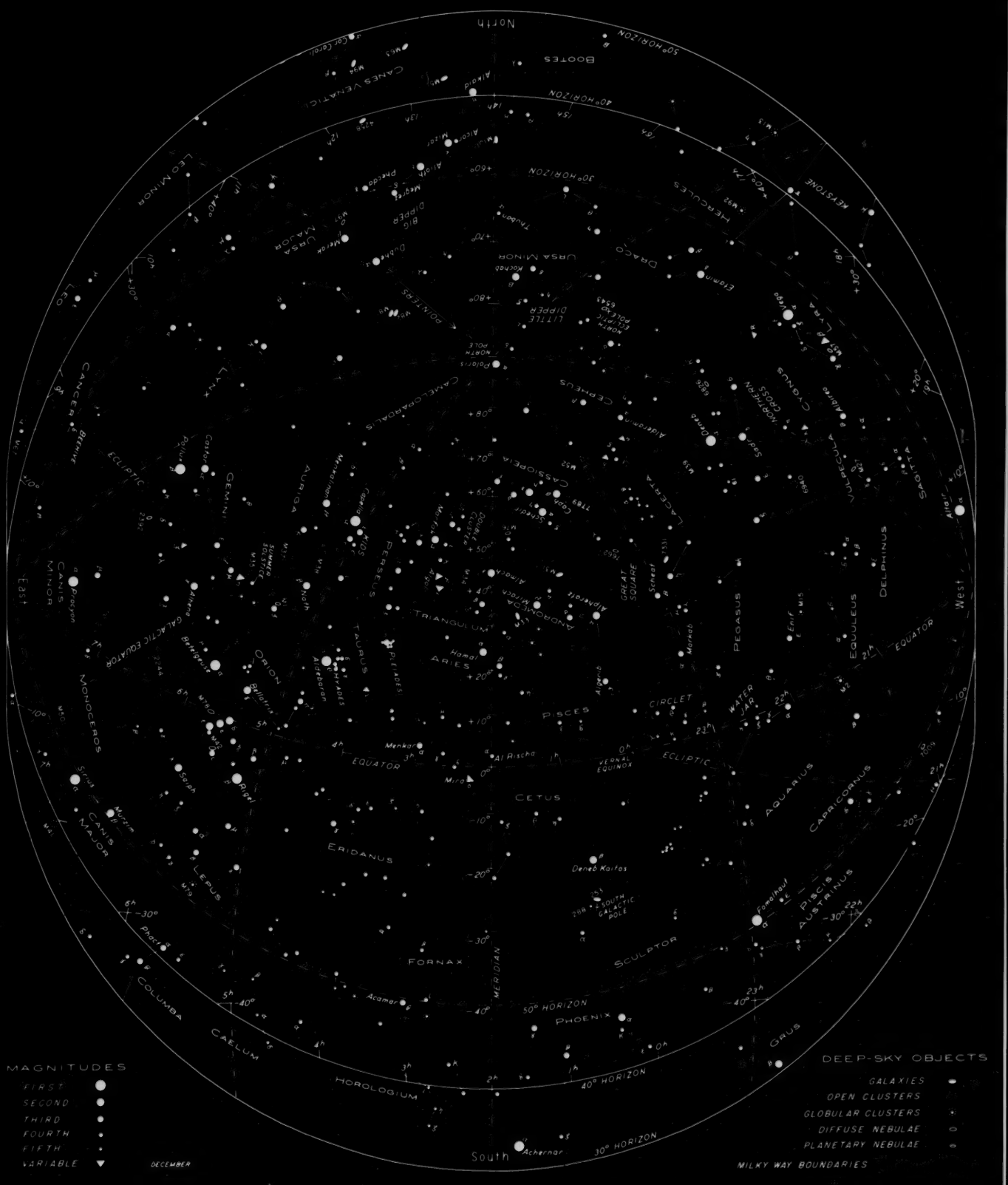
THE SKYSCOPE CO., INC. **475-s Fifth Avenue, New York 17, N. Y.**



SOUTHERN STARS

The sky as seen from latitudes 20° to 40° south, at 11 p.m. and 10 p.m., local time, on the 7th and 23rd of February; also, at 9 p.m. and 8 p.m. on March 7th and 23rd. For other dates, add or subtract ½ hour per week.

This chart matches the northern chart for March, which an equatorial observer can use to identify stars north of the limit of this chart (38S). Southern charts appear every other month, for sky positions several months in advance, for the convenience of distant observers.



STARS FOR DECEMBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of December, respectively; also, at 7 p.m. and 6 p.m. on January 7th and 23rd. For other dates, add or subtract ½ hour per week.

This month the "watery" constellations can be studied. Aquarius, the Water Carrier, and Piscis Austrinus, the Southern Fish, are toward the west; Pisces, the Fishes, and Cetus, the Whale, are on the meridian; and Eridanus, the River, winds in the southeast.

SKY-GAZERS EXCHANGE

Classified advertising costs 15 cents a word, including address; minimum charge, $3.00 per ad. *Remittance must accompany order.* Insertion is guaranteed only on copy received by the 20th of the second month before publication; otherwise, insertion will be made in next issue. We cannot acknowledge classified ad orders. Sky Publishing Corporation assumes no responsibility for statements made in classified ads, nor for the quality of merchandise advertised. Write Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Massachusetts

METEORITES for research, lectures, and demonstrations, found around the Arizona crater, $3.00, $5.00, $10.00. Odessa, Tex., meteorites, $1.00, $2.00, $3.00, $5.00. Scientific Laboratory, 2846 Oakley Ave., Baltimore 15, Md.

FOR SALE: Brass rack-and-pinion eyepiece holder, 2" movement, takes standard 1¼" eyepiece. $5.95 postpaid. Satisfaction or money refunded. Donald Lehr, 31 S. Hood Ave., Audubon 6, N. J.

"TARGET: EARTH" is collision geology. This book presents and evaluates evidence of repeated collisions of large meteors with the earth. Authors—Allan O. Kelly and Frank Dachille. 263 pages, $5.00. Target: Earth, Box 335, Carlsbad, Calif.

GALILEO'S TELESCOPE Replica: A full-size working copy of the original telescope. See the celestial objects as Galileo saw them. $10.00 postpaid. Parabola Optical Co., Box 194, Tenafly, N. J.

FOR SALE: Beautiful new 2½" equatorial refractor with slow motion in right ascension made by famous Nikon Optical Co. Focal length 980 mm. With 3 eyepieces, finder scope, zenith prism, zenith finder, sun glass, sun projector, and terrestrial eyepiece. All in polished hardwood box, $175.00. Robert Strother, Hanover Rd., Yorktown Heights, N. Y.

FOR SALE: Portable 8" equatorial reflector, $165.00. Sturdy mount. J. C. McDonald, 4212 Concord St., Midland, Mich.

FOR SPIDERS it's Snyder's. Top quality, lowest prices. Blackened brass, machine turned. Free catalogue. New address: Harold Snyder, Walbridge, Ohio.

ASTRONOMICAL SLIDES: 35 mm. For teachers, lecturers, amateurs, professionals. Only 25¢ each. New free catalogue. Martin Kantor, 129 Rockaway Parkway, Brooklyn 12, N. Y.

OUR LATEST catalogue features five different polishing agents, new low-cost grinding tools, diamond dust, saddler's punches, high strength pitch and many hard to find items. It will be a pleasure to send you your free copy. Nye Optical Co., 2100 Cherry Ave., Long Beach 6, Calif.

ASTRONOMICAL TELESCOPES. Astronomical books—over 80 titles. Microscopes, binoculars. For over 20 years the house of guaranteed quality. Rasmussen and Reece, Amsterdam, N. Y.

FIBERGLASS REINFORCED, seamless astronomical telescope tubes for sale. Featuring low thermal conductivity, one third weight of aluminum, rigid strength and perfectly round. Each tube custom built by the originator of this type tube. Standard and special sizes. Write—W. R. Parks, 16815 Faysmith, Torrance, Calif.

NORTON'S *Star Atlas and Reference Handbook*, latest edition, 1954, $5.25; Elger's *Moon Map*, $1.75; *Bonner Durchmusterung*, both northern and southern parts, $100.00. All domestic and foreign publications. Write for new list. Herbert A. Luft, 42-10 82nd St., Elmhurst 73, N. Y.

NEW BOOKS: Fred Hoyle, *Frontiers of Astronomy*, $5.00; Wilkins, *Mysteries of Time and Space*, $3.50; Ellison, *The Sun and Its Influence*, $4.50. Forthcoming: Wilkins and Moore, *The Moon*. Herbert A. Luft, 42-10 82nd St., Elmhurst 73, N. Y.

WANTED: ASTRONOMER interested in planetarium education. Requirements: Young man, Ph.D. in astronomy, lecturing and teaching experience. Would handle expanding college lecture program in addition to sharing public lectures with present staff. Write J. M. Chamberlain, General Manager, American Museum-Hayden Planetarium, New York 24, N. Y.

MOUNTED 5" and 6" refractor objectives of first quality, $220.00 and $325.00. 4" edged blanks, $15.00. Correspondence invited. Earl Witherspoon, Sumter, S. C.

DISPOSAL SALE: All equipment in my optical shop at half price. Excellent condition. Take all or part. Donald Ellison, Ludlow, Vt.

DEEP-SKY WONDERS

IT IS DECEMBER again and the stars have an extra snap and sparkle. The humidity is down, objectives do not dew up, and the warmly dressed observer is as happy as on June nights. The Northern Cross is erect in the northwest; Albireo has already set. Pegasus is now a great diamond-shape sloping slowly to the west, as Orion mounts closer to the meridian. This is no time for routine or difficult objects; it is better that we sweep again the old favorites of our youth—the sights that enthrall one with a first home-made reflector.

Name	*Messier*	*NGC*	*1950* h m	° ′	*Mag.*	*Dia.* ′	*Type*
Pleiades	45	—	3 44.5	+23 57	—	120	Open Cl.
Doub. Cl.	—	869, 884	2 17.2	+56 54	5.5	40	Open Cl.
Hyades	—	—	4 16.7	+15 31	—	400	Open Cl.
(Auriga)	38	1912	5 25.3	+35 48	7	18	Open Cl.
(Auriga)	36	1960	5 32.8	+34 06	6	16	Open Cl.
Crab	1	1952	5 31.5	+21 59	10	6 x 4	Planetary
(Orion)	78	2068	5 44.2	+00 02	—	8 x 6	Diffuse
(Lepus)	79	1904	5 22.2	−24 34	8	8	Globular
Orion Neb.	42	1976	5 32.9	−05 25	—	66 x 60	Diffuse

The Pleiades must come first, that marvelous cluster which in opera glasses is more splendid than most galactic clusters in a 10-inch. But if we have a 10-inch the splendor may keep us at the eyepiece for long moments. Perhaps we can faintly see the Merope nebula—it is not impossible. Next we pause for a brief glance at the Hyades, bright with piercing sparkle.

After this comes the great Double Cluster in Perseus. To the naked eye it shines with a steady glow between Cassiopeia and Perseus, and in the telescope this tremendous blaze of scintillating suns makes a commanding entrance into the eyepiece field. One can look for a long time at the many doubles, the colors, the winding patterns, as the dense cores of the cluster thin out slowly to merge finally in the star-rich background of the galaxy itself.

Moving down the Milky Way we run into such variegated star fields and clusters in Auriga that it is almost impossible to know where to halt, but this might very well be at M38. Evenly compressed into a glowing ball two thirds the diameter of the full moon are over 100 softly blazing stars. Nearby is M36, a rich cluster of fainter stars, somewhat smaller but also impressive. It is well to trail the telescope slowly over the whole length of the Milky Way in Auriga, for objects unmentioned in these regions would be major sights in most other parts of the sky.

Farther to the south, we pause for a moment at M1, the famous Crab nebula, although our telescopes will show little more than an oval glow, with no trace of wispy filaments. M1 was stumbled upon by Messier when observing the comet of 1758, and it induced him to form his famous catalogue; it was also in the search region for the 1835 return of Halley's comet. Less known, but still one of my favorites, is the diffuse nebula M78 in Orion, with a few stars apparently superimposed. It has a curious "ink-blot" symmetry.

Next in numerical order is M79 in Lepus, an 8th-magnitude globular cluster eight minutes of arc in diameter. Finally, saving the most impressive for last, is the incomparable M42, the great Orion nebula, about which words fail. No amount of intensive gazing ever encompasses all its vivid splendor.

WALTER SCOTT HOUSTON

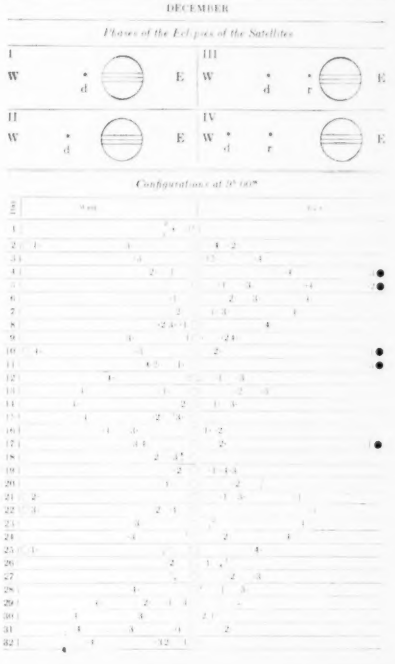
UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

JUPITER'S SATELLITES

The configurations of Jupiter's four bright moons are shown below, as seen in an astronomical or inverting telescope, with north at the bottom and east at the right. In the upper part, *d* is the point of disappearance of the satellite in Jupiter's shadow; *r* is the point of reappearance.

In the lower section, the moons have the positions shown for the Universal time given. The motion of each satellite is from the dot toward the number designating it. Transits over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the *American Ephemeris and Nautical Almanac*.



Brandon Orthoscopic Oculars

☆ During the past ten years, we have produced several thousand of our orthoscopic oculars, which have been highly praised by the casual amateur observer as well as the serious professional astronomer throughout the world.

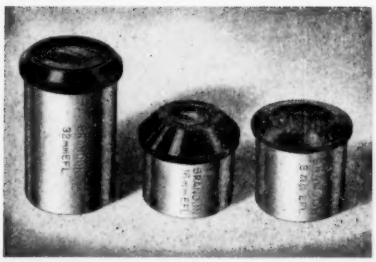
☆ Many attempts have been made to duplicate both the appearance and performance of these oculars. The market has been flooded with war-surplus optics and Oriental and European imports for which the performance is often mediocre. These less satisfactory eyepieces have actually increased our sales.

☆ To keep pace with the demand, we have established our research and production facility in Puerto Rico. Here we have willing American labor, ideal climatic conditions to produce quality optical components, and unlimited visibility both day and night for field testing. We are confident we can produce the finest astronomical components available at competitive prices.

☆ Rather than resort to high-pressure claims, we prefer to let our oculars sell themselves. We only ask that before you purchase your next eyepiece you consider its performance. This may be confirmed for Brandon oculars by consulting your local planetarium or observatory, your astronomical society, or your college or university science department. Of course our best salesman is the owner of a Brandon ocular.

☆ We urge you to purchase an eyepiece 1¼ inches in diameter, regardless of who makes it—most imported eyepieces have substandard diameters, with necessarily smaller lens components that seriously restrict the field of view.

☆ The painstaking care that you have put into your mirror or telescope can be nullified by an inferior eyepiece. We sincerely believe the Brandon orthoscopic ocular is the best available, regardless of price. Here's why:



1. Four-element design giving a flat, beautifully corrected field of 50° covering more than 160 per cent of the area of the conventional Ramsden for the same power. This eyepiece is a "must" for RFT work.
2. Precision optical elements, magnesium fluoride hard coated, increasing the light transmission approximately 10 per cent.
3. Simple take-down for cleaning.
4. Precision metal parts black anodized for anti-reflection and ground to 1¼" O.D.
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These eyepieces are produced in 4-mm., 8-mm., 16-mm., and 32-mm. effective focal lengths.

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GUAYNABO, PUERTO RICO

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See pages 92 and 93.

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